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MAGNUM-2D Computer Code: Users Guide

January 1985

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Prepared for Rockwell Hanford Operations,
a Prime Contractor to the U.S. Department of Energy
under Contract DE-AC06-77RL01030



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ABSTRACT

In this report, information relevant to the general use of the MAGNUM-2D computer code is presented. This computer code was developed for the purpose of modeling (i.e., simulating) the thermal and hydraulic conditions in the vicinity of a waste package emplaced in a deep geologic repository. The MAGNUM-2D code computes (1) the temperature field surrounding the waste package as a function of the heat generation rate of the nuclear waste and thermal properties of the basalt and (2) the hydraulic head distribution and associated groundwater flow fields as a function of the temperature gradients and hydraulic properties of the basalt.

MAGNUM-2D is a two-dimensional numerical model for transient or steady-state analysis of coupled heat transfer and groundwater flow in a fractured porous medium. The governing equations consist of a set of coupled, quasi-linear partial differential equations that are solved using a Galerkin finite-element technique. A Newton-Raphson algorithm is embedded in the Galerkin functional to formulate the problem in terms of the incremental changes in the dependent variables. Both triangular and quadrilateral finite elements are used to represent the continuum portions of the spatial domain. Line elements may be used to represent discrete conduits.

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1.0 INTRODUCTION

1.1 BACKGROUND

A suite of numerical models (i.e., computer codes) has been developed and interfaced for use in assessing the long-term isolation performance of a repository in basalt (DOE 1982). These models are based primarily on deterministic approaches (Estey et al. 1985; Kline et al. 1983); however, certain codes are formulated on a probabilistic framework (Baca et al. 1984b; Sagar and Clifton 1983; Clifton et al. 1983). The numerical models are grouped by space scale into three categories:

1. Waste package scale (very near-field) models
2. Repository scale (near-field) models
3. Regional scale (far-field) models.

The waste package scale models provide predictions of the temperature and flow field around the waste package and radionuclide release rates from the waste package and/or emplacement horizon. The repository scale models are designed to calculate groundwater flow paths and traveltimes, the large-scale temperature field around the repository, and radionuclide concentrations and releases. Results from the repository scale analysis provide boundary conditions for regional scale predictions of groundwater traveltimes to and cumulative releases at the boundary of the accessible environment.

This report focuses on one of the deterministic waste package scale models designated as MAGNUM-2D. The MAGNUM-2D code is a two-dimensional finite-element code applicable to a fractured porous medium. This computer code is capable of simulating the coupled or uncoupled processes of heat transfer in a water/rock system and groundwater flow in an inhomogeneous anisotropic medium. In addition, it provides the capability of simulating flow in discrete conduits or fractures (macroscale discontinuities). The conceptual modeling approach is based on representing the physical system by a two-dimensional cross section. Three-dimensional systems with axial symmetry can also be modeled with MAGNUM-2D. A set of support codes and graphics software has been developed and interfaced with the MAGNUM-2D code to (1) generate, manipulate, and display the finite-element grid; (2) compute and plot pathlines/streamlines and traveltimes; and (3) plot contours, spatial cross sections, and time histories for temperature and hydraulic head. In addition, the data files generated by MAGNUM-2D are arranged to be used directly by the CHAINT computer code (Baca et al. 1984a), which simulates the transport of dissolved radionuclides.

This users guide provides detailed instructions regarding the use of the MAGNUM-2D computer code for waste package scale analysis of coupled groundwater flow and heat transfer. It also contains descriptions of input data requirements, as well as sample input and output for test cases.

1.2 PURPOSE AND SCOPE

The MAGNUM-2D computer code was developed by the Basalt Waste Isolation Project (BWIP) at Rockwell Hanford Operations (Rockwell) for use in studies of nuclear waste disposal in deep geologic repositories (Baca et al. 1984a, 1984b; Baca et al. 1981). Subsequent enhancements as well as ongoing maintenance are provided by Boeing Computer Services Richland, Inc., Richland, Washington. This document is intended to serve as a users guide for version 3.1 of the code as it exists at the BWIP computing facility. It is noteworthy that earlier versions of MAGNUM-2D have been implemented on a UNIVAC 1100/44 and a CRAY 1, as well as PRIME minicomputers. The current version is installed on a PRIME 750 minicomputer network. Although the BWIP version of MAGNUM-2D is maintained and used in a PRIME operating environment, transportability of the code has been given high priority. Features of the current version of the MAGNUM-2D computer code as described herein are machine independent except for the isolated service subroutines noted in Appendix A.

The format and content of this users guide are with respect to guidance given by the U.S. Nuclear Regulatory Commission (Silling 1983). The partial differential equations solved by MAGNUM-2D and the numerical method are discussed in Section 2.0. The general usage considerations and capabilities are discussed in Section 3.0, while detailed instructions for inputting a given problem are given in Section 4.0. The output obtainable from MAGNUM-2D is described in Section 5.0. The possible machine/environment dependencies are discussed in Appendix A. Included as Appendixes B and C are descriptions and short discussions of several preprocessors and postprocessors that may be used to assist in preparation of the input data for MAGNUM-2D and the interpretation of the output data. The input data and output listings for some example problems, along with examples of plots generated by preprocessor and postprocessor graphics programs, are given in Appendix D. Diagnostic messages generated by MAGNUM-2D are tabulated in Appendix E.

2.0 MATHEMATICAL FRAMEWORK

2.1 GOVERNING EQUATIONS

The MAGNUM-2D computer code is designed to simulate steady-state and time-dependent coupled processes of buoyancy-driven fluid flow in a fractured porous medium and advective and conductive heat transfer in a porous continuum. The code is applicable to problems that can be formulated in two dimensions over rectangular or axially symmetric cylindrical domains. The mathematical model is founded on the physical laws of fluid continuity and conservation of momentum and energy (Fahien 1983; Malvern 1969). Discussions on the theoretical bases may be found in Baca et al. (1984a); however, for completeness, the governing equations are also given here.

The equation governing nonisothermal flow balance in a porous continuum as written in indicial notation for a Cartesian coordinate system is.

$$S_s \frac{\partial h}{\partial t} = \frac{\partial}{\partial x_i} \left[K_{ij} \left(\frac{\partial h}{\partial x_j} + \delta_{ij} \delta_{12} \right) \right] + \gamma \frac{\partial T}{\partial t} \quad (1)$$

where

S_s = specific storage of the porous rock matrix

h = hydraulic head

t = the time coordinate

x_i = space coordinates (x, y)

K_{ij} = principal hydraulic conductivities of the rock matrix
(K_{xx} and K_{yy})

δ_{ij} = density disparity

δ_{12} = the Kronecker delta

γ = thermal coupling coefficient

T = temperature of the water/rock system.

Note that the principal axes of the hydraulic conductivity tensor are assumed to coincide with the coordinate axes and, hence, only components of flow in the principal directions are considered. Furthermore, the density disparity and thermal coupling coefficient are given by

$$\delta_{ij} = \frac{\rho - \rho_0}{\rho^*} \quad (2)$$

and

$$\gamma = \phi \beta, \text{ respectively} \quad (3)$$

where

ρ = fluid density as a function of location (x, y) and time

ρ_0 = initial fluid density as a function of vertical location (y)

ρ^* = reference fluid density

ϕ = effective porosity

β = bulk modulus of fluid.

The equation governing nonisothermal flow balance in a fracture as written for a local one-dimensional coordinate system is

$$S_f \frac{\partial h}{\partial t} = \frac{\partial}{\partial L} \left[K_f \left(\frac{\partial h}{\partial L} + \delta_b' \right) \right] + \gamma \frac{\partial T}{\partial t} \quad (4)$$

where

S_f = specific storage in the fracture

L = local space coordinate

K_f = hydraulic conductivity of (filled or unfilled) fracture

δ_b' = component of the density disparity along L .

For an unfilled fracture, the hydraulic conductivity is determined by (Snow 1969)

$$K_f = \frac{ge^2}{12v} \quad (5)$$

where

g = acceleration due to gravity

e = fracture aperture

v = kinematic viscosity of the fluid.

Under the assumption that the fluid and rock mass are in thermal equilibrium at all times (Combarnous and Bories 1975), the governing thermal energy balance equation written for Cartesian coordinates using indicial notation is

$$S_t \frac{\partial T}{\partial t} + \rho c_f q_i \frac{\partial T}{\partial x_i} = \frac{\partial}{\partial x_i} \left(D_{ti} \frac{\partial T}{\partial x_j} \right) + Q \quad (6)$$

where

S_t = heat capacity of the fluid/rock system

c_f = specific heat of the fluid

q_i = component of the Darcy velocity vector $\left(-K_{ii} \frac{\partial h}{\partial x_i} \right)$

D_{ti} = effective thermal conductivity

Q = volumetric rate of heat generation.

Moreover,

$$S_t = \phi \rho c_f + (1-\phi) \rho_s c_s \quad (7)$$

where

ρ_s = bulk density of the rock

c_s = specific heat of the rock,

and

$$D_{tx} = \phi D_f + (1-\phi) D_s x + \left(\alpha_L q_x^2 + \alpha_T q_y^2 \right) \frac{\rho c_f}{\bar{q}} \quad (8)$$

and

$$D_{ty} = \phi D_f + (1-\phi) D_s y + \left(\alpha_T q_x^2 + \alpha_L q_y^2 \right) \frac{\rho c_f}{\bar{q}} \quad (9)$$

where

D_f = thermal conductivity of the fluid

D_s = thermal conductivity of the rock

α_L = longitudinal dispersivity

α_T = transverse dispersivity

$\bar{q} = (q_x^2 + q_y^2)^{1/2}$, the groundwater speed.

Again, as with the flow equation, cross-product terms are assumed to be negligible. Heat transfer along a fracture is handled analogously to flow in the fracture (i.e., in one dimension).

The MAGNUM-2D computer code is programmed to solve the governing equations in Cartesian or radial coordinates (Eq. 1, 4, and 6) subject to initial and boundary conditions using a Galerkin finite-element method. The flow equations are solved simultaneously. The flow and heat transfer equations are solved in alternating sequence. The units of the constants, coefficients, and state variables are given in the nomenclature list comprising Section 6.0.

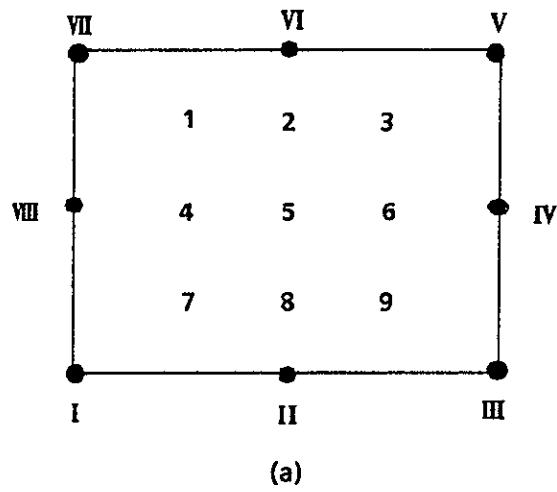
2.2 SPATIAL DISCRETIZATION

The finite-element method employed by MAGNUM-2D in solution of the governing equations (Eq. 1, 4, and 6) is implemented in a fashion that affords substantial flexibility in discretization of the spatial domain. An arbitrarily shaped planar domain may be discretized over a Cartesian global coordinate system as long as it is topologically connected and has a continuous boundary. A bounded disk, cylinder, or annulus may be discretized over a radial global coordinate system. In practice, this latter case amounts to representation of a vertical cross section in Cartesian coordinates and specification of an appropriate angle of revolution. Note that in a radial coordinate system, a line element superimposed on a vertical cross section of a cylinder defines a surface intersecting the cylinder.

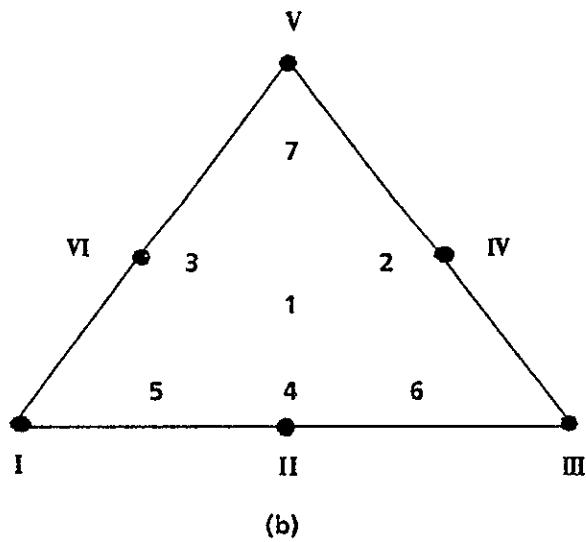
Linear or quadratic Lagrangian one-dimensional elements (Huyakorn and Pinder 1983) may be used to represent a one-dimensional domain. Isoparametric triangular and/or serendipity elements (Huyakorn and Pinder 1983) may be used in combination with line elements for discretization of a two-dimensional domain. Both linear and quadratic Langrangian shape functions may be used with the two-dimensional elements as well.

Typical one- and two-dimensional elements show the placement of nodes (denoted by Roman numerals) and Gauss points (denoted by Arabic numerals) for quadratic-shape functions in Figure 1 and the same for linear-shape functions in Figure 2. Note that the transport variables, h and T , are defined at the nodes, and the Darcy velocities, U and V , are defined at the Gauss points.

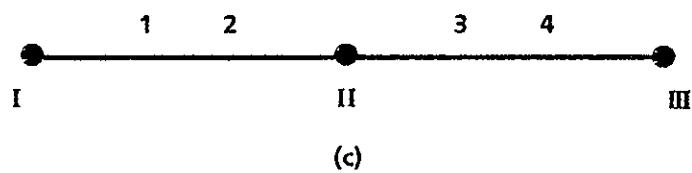
Guidance for selection of element types and shape functions is provided in Sections 3.1 and 3.2. Detailed descriptions of MAGNUM-2D input options and formats are given in Section 4.0. Automated procedures for construction of a complete finite-element grid system is outlined in Appendix B. Two-dimensional plots of a grid system used for an example problem may be found in Appendix D.



(a)



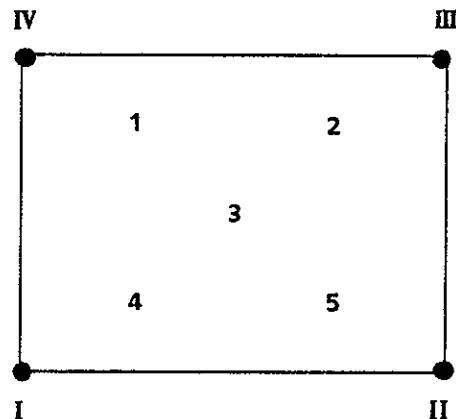
(b)



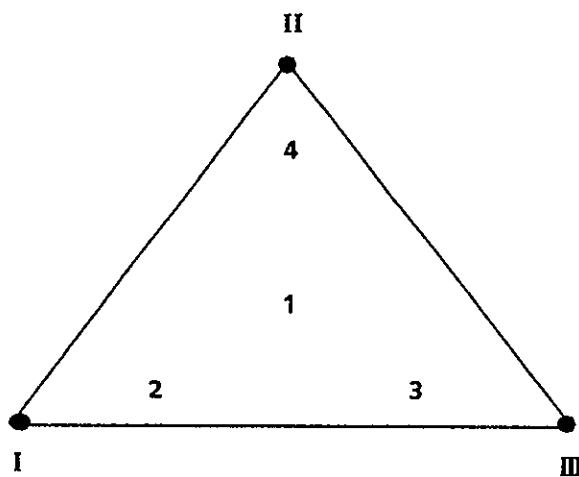
(c)

PS84-2131-1

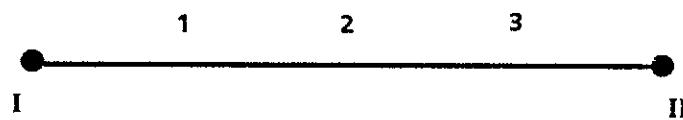
FIGURE 1. Locations of Nodes and Gauss Points for Quadratic-Shape Functions (a) Quadrilateral Element, (b) Triangular Element, and (c) Line Element.



(a)



(b)



(c)

PS84-2131-2

FIGURE 2. Locations of Nodes and Gauss Points for Linear-Shape Functions (a) Quadrilateral Element, (b) Triangular Element, and (c) Line Element.

2.3 INITIAL CONDITIONS

Solutions of the governing equations (Eq. 1, 4, and 6) are dependent upon the initial conditions of the state variables h and T . To facilitate the present as well as later discussions, let F denote a generalized state variable (i.e., either h or T) and let F_k^0 denote the value of F at the k^{th} node at the l^{th} time step. Then, a global initial condition may be written

$$F_k^0 = \text{constant}, \quad 1 \leq k \leq NP \quad (10)$$

where NP denotes the total number of nodes in the spatial domain. If no initial conditions are specified for F , then Equation 10 is assumed where the constant is taken to be zero. Explicit specification of the above form (Eq. 10) is easily accomplished according to instructions given in Section 4.0. Alternately, a spatially varying initial condition may be written

$$F_k^0 = F(x_k, y_k, t^0), \quad 1 \leq k \leq NP. \quad (11)$$

Use of this form requires specification of the initial value of F at each node. Manual setup of the input corresponding to this form (Eq. 11) can be tedious if NP is large, and hence there exists a preprocessor that provides automated generation of an initial condition file as described in Appendix B.

The foregoing description of initial conditions is germane to transient analysis of fluid flow and/or heat transfer. However, MAGNUM-2D is also equipped to perform steady-state solution of the governing equations. In this case, starting values for solution of the steady-state distribution of F may be specified in the same manner as initial conditions.

2.4 BOUNDARY CONDITIONS

The MAGNUM-2D computer code is generally applicable to problems involving solution of Equations 1, 4, and 6 over a domain meeting the requirements given in Section 2.2. However, MAGNUM-2D is utilized primarily in the analysis of waste package scale phenomena. At this scale differentials (i.e., gradients) are typically small, and hence the default boundary condition for F is taken from

$$\left. \frac{\partial F}{\partial z} \right|_{x=x_B, y=y_B} = 0 \quad (12)$$

where (x_B, y_B) denotes a boundary node and z is a coordinate normal to the boundary. Optionally, one may specify a Dirichlet boundary condition for F at any boundary node.

Formatting of input for optional boundary conditions can prove to be tedious. To further facilitate the setup of a MAGNUM-2D simulation, a preprocessor is available to generate a boundary condition file as described in Appendix B.

2.5 NUMERICAL SOLUTION METHOD

The finite-element method employed by MAGNUM-2D in solution of the governing equations (Eq. 1, 4, and 6) is based on a Galerkin approach (Huyakorn and Pinder 1983). A substantial derivation of the method is given by Baca et al. (1984a). A summary, along with complementary details, is provided in the following paragraphs.

Consider an arbitrarily selected element containing m nodes. Then an approximation to F over the element is written

$$F \doteq \sum_{k=1}^m \omega_k F_k \quad (13)$$

where ω denotes a shape function. Let ϵ denote the error due to the approximation (Eq. 13). Then the Galerkin approach to weighted residuals is based on minimization of the error, ϵ , through the functional

$$X = \int_E \omega_k \epsilon dE \quad (14)$$

where E is the current element. The finite-element equations are formulated in terms of incremental change in F by using a Newton-Raphson algorithm for ϵ in Equation 14 (Baca et al. 1978, 1984a). Communication between fractures and the porous continuum is achieved by superposition which amounts to summing the functionals for hydraulic head in a continuum element and hydraulic head in an adjacent fracture.

Expansion of terms for the system of finite-element equations derived for a single element is illustrated by Baca et al. (1984a). Derivatives of F with respect to time as occur in the element equations are approximated by linear combinations of differences over incremental times written

$$\frac{\partial F^{l+1}}{\partial t} = \frac{\partial F}{\partial t} \Bigg|_{t=t^{l+1}} \doteq \theta \frac{F^{l+1} - F^l}{t^{l+1} - t^l} + (1-\theta) \frac{\partial F^l}{\partial t}. \quad (15)$$

The value of F^{l+1} as used in Equation 15 is calculated from a non-iterated Hermite-Milne predictor-corrector method characterized by the two stages

$$F^{l+1} = -4F^l + 5F^{l-1} + (t^{l+1} - t^l) \left(4 \frac{\partial F^l}{\partial t} + 2 \frac{\partial F^{l-1}}{\partial t} \right) \quad (16)$$

and

$$F^{l+1*} = F^{l-1} + \frac{t^{l+1} - t^l}{3} \left(\frac{\partial F^{l+1}}{\partial t} + 4 \frac{\partial F^l}{\partial t} + \frac{\partial F^{l-1}}{\partial t} \right) \quad (17)$$

where F^{l+1*} is the corrected value of F^{l+1} .

The weighting factor, θ , in Equation 15 may be specified by the user. Suggested values range between one and two; a value of one corresponds to a first order backward difference approximation, whereas a value of two corresponds to a second order backward difference approximation.

Assembly of the blocks of element equations yields a banded system of linear algebraic equations that is solved using a Gaussian frontal-solution technique. The frontwidth of the system is a factor in the amount of memory and processing time needed to solve the system of equations (Irons and Ahmad 1980). In turn, the frontwidth is dependent upon element numbering. Hence, as described in Appendix B, there is a preprocessor available to optimize the element numbering in the respect that the frontwidth is minimized.

3.0 GENERAL INPUT CONSIDERATIONS

3.1 MODEL GENERATION

The generation of a finite-element model requires careful consideration of the processes being simulated and the limitations of the finite-element technique. Detailed consideration of these points is outside the scope of this document. It is assumed that the user is versed in finite-element applications and thus needs only a discussion of the use of this particular code.

In general, the majority of the time required in formulation and generation of a finite-element model is spent in developing the grid that represents the physical domain. This consists of determination of the points that define the corners of the elements and specification of the connectivity that defines the set of nodes describing each element.

One of the advantages of the finite-element approach used in MAGNUM-2D is that it permits the use of a "graded" mesh. A graded mesh is a variable computational grid that is coarse in areas of low gradients and is fine in areas of high gradients. The significance of the graded mesh is that it permits accurate representation of the spatial domain and its boundaries, and it minimizes the space truncation error, thus optimizing the computational problem. Selection of the mesh layout is, therefore, one of the most important steps in applying the code.

Mesh generation for a practical simulation problem is generally an iterative process. For problems of coupled heat and flow, the numerical solution of the flow equations (Eq. 1 and 4) usually requires the finer mesh layout (i.e., greater spatial resolution). The generation process begins with a trial mesh layout that is selected to conform with the anticipated solution field(s) and system boundaries. A test simulation is performed with MAGNUM-2D, and the results are analyzed. For cases involving fluid flow, the pathlines are calculated, plotted, and checked. From these initial results, the grid is refined as needed. This process is repeated until the simulation results show convergence to a reasonable solution.

Time may be saved in the geometry definition phase of the problem formulation by making use of the preprocessing utilities described in the appendixes, specifically, GEN and FEMESH to generate the mesh, MESHER to optimize it, PURGE to verify it, and BCGEN to identify the boundary nodes. In addition, there is a processor called PLT that displays the geometry on a graphics terminal and a family of postprocessors that assist in the analysis of the output data.

The following guidelines should be considered in generating a two-dimensional finite-element mesh.

- Quadrilateral elements should be used for most of the mesh, and if necessary, triangular elements should be used for transition regions; line elements are used for discrete fractures.
- Element aspect ratios should not exceed roughly 100.
- Midside nodes should be located in the middle third of the element side or length.
- The element numbering sequence should be continuous and should begin along the side of the grid with the fewest elements.

The MAGNUM-2D computer code uses a frontal solution algorithm developed by Hood (1976) to solve unsymmetric finite-element matrix equations. This technique is an implementation of Gaussian elimination in which the assembly of equations alternates with their solution. With respect to accuracy, the algorithm is insensitive to node numbering and independent of matrix bandwidth. The numbering of the elements, however, must be assigned in a contiguous and optimal sequence to assure computational efficiency. In general, the optimal element numbering begins along the side of the mesh with the fewest elements. A preprocessor program, designated as MESHER, has been developed that reads a finite-element mesh (element-node table and nodal coordinate list), reorders the element numbering sequence, and outputs the optimized mesh layout.

3.2 ELEMENT TYPES

The MAGNUM-2D computer code uses a grid system composed of quadratic and linear elements such as those depicted in Figures 1 and 2. The grid layout is defined by an element-node table (connectivity definition) and a list of nodal coordinates (geometry definition). Node numbers for any element must be entered in a counterclockwise manner starting at any corner node. The finite-element grid consists of any combination of quadrilateral and triangular elements with line elements superimposed along element boundaries as needed.

By default, quadratic-shape functions are used to approximate the state variables, h and T , over each finite element. This default may be overridden by specifying a "zone" as part of the input data. The state variables are approximated within the zone using quadratic-shape functions as normal, but all elements outside the zone are approximated with linear-shape functions. Midside nodes are automatically averaged by MAGNUM-2D for any linear zone elements, thus reducing the number of unknowns. The elements and the node numbering used for linear-shape function elements are shown in Figure 2. Using linear-shape functions in domain areas with gradually varying-state variables can save substantial computer run time.

In addition to the zone definition technique mentioned above, the user may also specify elements with linear-shape functions directly. During input, the user enters zero or blank for all midside nodes. The MAGNUM-2D computer code will detect these "zero" nodes and use the linear-shape function.

Although the shapes and sizes of the continuum elements are arbitrary, it should be noted that the aspect ratio, roughly the ratio between the height and width of the element, can be a determining factor in the accuracy of the final results of a simulation. It has been found through experience that if the user maintains an aspect ratio of less than 100, the results will be reasonable.

The modeling of macrofeatures such as fractures will at times require a tradeoff between the best fracture geometry representation and the number and location of the continuum elements. One fracture width is allowed per material type. Several material types may be defined with their fracture widths being the only difference in the rock properties. The line element representing the fracture is treated as isotropic. Regardless of the fracture orientation in the domain, the x-direction conductivity value is used along the fracture length, and a zero-conductivity value is used across the fracture width. The specified fracture permeabilities must be greater than the permeability of the surrounding medium. Moreover, a line element and a continuum element cannot be assigned the same material type index.

In addition to the modeling considerations, care should be exercised in placing the continuum elements so that the various material types are in their proper orientation and location. Material types may only be specified on an element-by-element basis, so material boundaries must coincide with element boundaries.

3.3 INITIAL CONDITIONS

A global or local initial value of a state variable, F , may be specified as summarized by Equations 10 and 11, respectively. The role of initial conditions in a simulation of transient phenomena is obvious. For a steady-state simulation, the initial conditions are taken as starting values in that the steady-state value of F is

$$F_k = F_k^0 + \Delta F_k \quad (18)$$

where ΔF_k represents the incremental change in F after a single iteration.

For steady-state applications the default value of zero for starting values may be as good as any other starting value in that the steady-state value, F_k , and the amount of computer time needed to obtain it are independent of the starting value, F_k^0 . As an exception, starting values

of temperature may be important in steady-state flow if the user wishes to account for temperature dependence of hydraulic conductivity. A tacit assumption in this exceptional case is that the initial temperatures are actually steady-state temperatures. Of importance though is merely acquainting the user with the capability of specifying starting values for steady-state applications.

3.4 BOUNDARY CONDITIONS

The MAGNUM-2D computer code is designed principally for simulation of nonisothermal fluid flow and heat transfer in the vicinity of a waste container under saturated groundwater conditions. Hence aquifer leakage, recharge, and pumping are not considered in the model. Heat sources are accommodated as described in the following section. At the outer boundary of the simulation domain, as well as along the axis of symmetry for a radial coordinate system, a zero flux boundary condition is taken by default for both state variables h and T .

Optional Dirichlet boundary conditions may be specified for either or both h and T at any boundary node. Note that specification of fixed temperature or head along the axis of symmetry for a radial coordinate system may be used to simulate a point, line, or cylindrical source of constant strength. No provision is made to allow any time dependent boundary conditions (except for internal heating as described in the next section).

3.5 HEAT SOURCES

Heat sources may be specified throughout the discretized spatial domain on an elemental basis. Use of this feature requires specification of the total number of elements to which a time-dependent heat load is applied, the numbers of the individual elements that bear the heat load uniformly, and the temporal profile of the common heat generation rate. As an option, one may also supply a scale factor that magnifies the thermal source strength. Provision of this scaling option is intended to facilitate user transition between simulations for which the heat loads are identical up to magnitude of source strength.

Zero heat loading is set by default. Alternately, for a transient simulation involving heat transfer processes, one may specify a heat generation rate through either of two methods. The more general of the two available source strength options allows the user to input the pairs of points of the form (t^i, Q^i) that define a piecewise-linear heat generation profile. An example of such a profile is depicted in Figure 3. The shaded area in this figure indicates the amount of thermal energy released per unit volume, ΔQ , over a time step of size Δt . Attainment of a constant source

strength requires a single pair of points. A step-change profile may be approximated by three pairs of points (i.e., four total points taken pairwise in increasing time). In general, a continuous piecewise-linear profile consisting of n segments requires $n+1$ points.

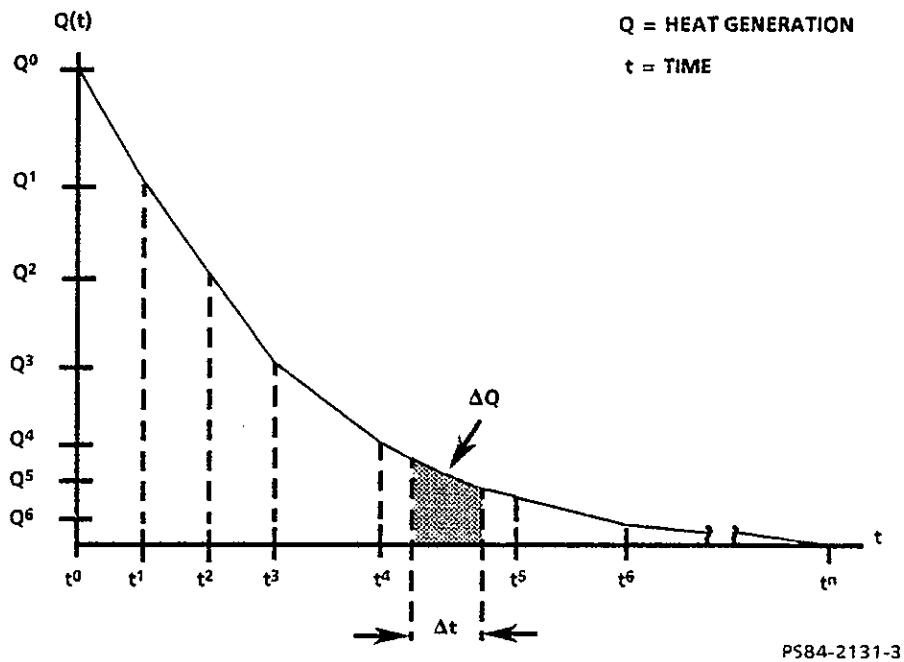


FIGURE 3. Typical Volumetric Heat Generation Profile.

The other source strength option is specially tailored to simulation of heat transfer around a waste package. In particular, under this option the source strength is the product of an initial volumetric heat load and a relative heat generation rate for 10-yr old unreplicated spent fuel (Hardy and Hocking 1978). Use of this option requires entry of the initial heat load, Q^0 , after which successive loads decay according to the empirical relation

$$Q^{\ell} = Q^0 \sum_{i=1}^{6} b_{i1} e^{-b_{i2} t^{\ell}} \quad (19)$$

where the coefficients b_{ij} are given in Table 1.

TABLE 1. Coefficients of
Relative Heat Generation.

i	b_{i1}	b_{i2}
1	0.00756	2.3×10^{-5}
2	0.0151	9.95×10^{-5}
3	0.1404	1.75×10^{-3}
4	0.677	2.166×10^{-2}
5	0.0504	4.03×10^{-2}
6	0.1093	2.912×10^{-1}

Both of the foregoing heat source strength options are programmed only for use in a transient simulation mode. To obtain a steady-state temperature distribution around a constant heat source, one must run a transient simulation covering at least one step of strictly positive duration. This is due to the nature of the piecewise-linear profile that is used to specify a constant heat source. Alternately for steady-state heat transfer around a constant source, it may be reasonable to assume a line of symmetry across the source and run a steady-state simulation in which an appropriate Dirichlet boundary condition is specified along a segment of the axis of symmetry.

3.6 TIME STEPPING

The time steps for a transient simulation may be subdivided into groups of equally sized steps. The number of steps of any given size is arbitrary. The user need only specify the step size and number of steps for each group of time steps as described in Section 4.0.

Apart from the procedural task of inputting time-step data is the need for criteria to gage step sizes. As a rule of thumb, a beginning time-step size should not be greater than the characteristic time

$$\Delta t_{ch} \equiv \min \frac{S(\Delta x)^2}{\Gamma} \quad (20)$$

where

S = generalized storage coefficient (S_s or S_t)

Γ = generalized conductivity (K or D_t)

Δx = internodal distance

and the minimum is taken over all pairs of adjacent nodes aligned in the principal direction of the gradient of F . A solution of the flow equations (Eq. 1 and 4) at the ℓ^{th} time step is generally stable as long as

$$\max_{1 \leq k \leq NP} \left\{ \frac{h_k^\ell - h_k^{\ell-1}}{h_k^{\ell-1}} \right\} \leq 10^{-4} \quad (21)$$

is maintained for the current step as well as all previous steps. Moreover, an empirical guideline for assessing the effectiveness of time steps during solution of the temperature equation (Eq. 6) is

$$\max_{1 \leq k \leq NP} \left\{ \frac{T_k^\ell - T_k^{\ell-1}}{t^\ell - t^{\ell-1}} \right\} \leq 10^{-2}. \quad (22)$$

Time steps chosen so that temporal changes of state variables are within the suggested limits (Eq. 21 and 22) will generally lead to stable results. However, gross undershoot of both criteria (Eq. 21 and 22) may be indicative of computational inefficiency.

Further considerations regarding computational efficiency stem from the need to update the stiffness matrix and load vector during time-stepping. The load vector must be updated at each time step. In the stiffness matrix, the temporal and spatial gradients of the dependent variables are differentiated with respect to themselves. The time derivative reduces to the weighting factor divided by the time-step size, while the spatial derivatives of the dependent variables reduce to spatial derivatives of the weighting function.

For two special cases, all the coefficients of the stiffness matrix are constant. These two cases are isothermal flow and uncoupled heat conduction. The stiffness matrix will change only when the time-step size is altered. Limiting the frequency of time-step size changes in these cases will significantly improve the efficiency of the simulations.

In contrast, when both the heat and flow equations are solved, the stiffness matrix must be reformed and inverted at each time step. Moreover, fluid density is thermally dependent, and hydraulic conductivity exhibits a weak temperature dependence due to viscosity changes. Conductivity and density values in the flow equations are updated based on temperatures from the previous time step, a technique known as "quasi-linearization." The diffusion term in the heat equation is linearized by assuming a constant diffusion coefficient, D_t , throughout the temperature range of interest, but the advection term must still be updated at each time step. Other coefficients are constant over time.

Run-time options described in Section 4.0 determine whether the flow and thermal equations are both being solved and whether they are coupled or uncoupled. The uncoupled solution uses thermal data from the first time step to solve the flow equation at all subsequent times. Groundwater systems vary slowly over time, so the error incurred is usually minimal if the time step is small. Computational savings are great. A parametric study of the domain should be implemented, however, before assuming uncoupled simulations are valid.

The simulation time in a transient run can be divided into several time intervals with different time-step sizes. Small time steps may be used when a thermal load is applied or after other abrupt changes in aquifer properties. At each time step, the incremental change in the dependent variables is found for each node. These incremental values are added to the previous time-step results to give the head and temperature values throughout the domain. State variables and their gradients are then updated based on these new data; thermally dependent coefficients are recalculated; the new matrix and load vector are formed; and the system of equations is solved. This procedure is repeated until the final simulation time is reached.

3.7 SIMULATION RESTART

Restart capabilities are particularly useful in simulations that span long time periods relative to the time-step size. The first interval of time steps can be checked for errors before continuing an extensive run. After a given time period, perturbations in the system can be simulated by changing values in the input data file and restarting the run. For instance, changes in fracture permeabilities and apertures could be used to account for other factors such as stress coupling effects.

The user flags the initial run to generate the restart output file by using parameter ICF to specify a logical unit number (LUN). The file so generated will contain data from the last time step completed. When the restart run is started, the LUN entered as ICF is specified as the input file using parameter IRS.

Note that the data file used as the initial input must be provided in its entirety, but modifications may be made to material properties or other parameters. No modifications may be made to the geometry.

3.8 EXECUTION CONTROL

Execution control parameters make up most of the parameters on the second and third input records. These two cards specify items such as the simulation mode, temperature options, moisture (fluid flow) options, type of initial conditions, output specifiers, and all of the LUNs used for files. In several cases, values entered in these records are used later during input to control the number of values to be entered (e.g., the number of nodes or elements). Note that not all the controlling parameters are located in these records. In some cases, they may immediately precede the table of values to be entered.

The LUN or file numbers entered on the third card often serve a dual capacity, e.g., the parameter IRS for restart. If this value is blank or zero, no restart is performed. When IRS is a positive number, it specifies the LUN to be read for restart and simultaneously indicates that a restart run is being made.

Details of all the input data may be found in Section 4.0 broken down by card type and parameter. Any interaction between control values and input data is fully explained in context.

3.9 DATA INPUT RECORDS

The input for MAGNUM-2D consists of a sequence of 80-character "card images." All the input is entered in fixed-length fields as defined in the following sections and consists of numeric or alphanumeric (character) data. It is entered in a manner consistent with the conventions of the FORTRAN programming language, of which an abbreviated description will be found in this section.

The input records are divided into a series of fields, each field being a fixed, predetermined number of characters in length. These fields may be used to enter either numeric or alphanumeric data. In the case of numeric data, there are two types: integer and real.

Integer numbers are entered as a string of numerals (0 through 9) with no decimal points. They may be preceded by an algebraic sign (+ or -), if required, and should not have any commas or blanks embedded in them. Examples are as follows:

- 100
- -53

- 0
- +1025.

In the descriptions that follow, an integer value is specified by using the FORTRAN editing code of Ixx, where the I stands for integer, and the xx is a number indicating the length of the field that will contain the integer number. Examples are as follows:

- I5 - Integer field 5 digits long
- I10 - Integer field 10 digits long.

All integers entered must fit within the field specified, or erroneous results will occur.

Real numbers can be entered in two forms. The first is called a real fixed-point number and is entered as a string of numerals with a decimal point. If required, they may be preceded by an algebraic sign and should not have any commas or blanks embedded in them. Examples are as follows:

- 3.14159
- 2034.
- -1.0
- +2.57.

In the descriptions that follow, a real fixed-point value is specified by using the FORTRAN editing code of Fxx.xx, where the F stands for real fixed, and the xx is a number indicating the length of the field that will contain the real number. The xx that follows the decimal point indicates the number of decimal places that will be assumed if no decimal point is entered. Examples are as follows.

- F10.2 - Real number in a field 10 digits long with an assumed decimal point two places to the left of the last digit. A number entered as 1024 will be interpreted as the value 10.24.
- F10.0 - Real number in a field 10 digits long with no assumed decimal point. A number entered as 1024 will be interpreted as the value 1024.

All numbers entered must fit within the field specified, or erroneous results will occur.

A real floating-point number consists of a string of numerals with a decimal point and may be preceded by a sign (as in the real fixed point number). However, the real floating-point number is followed by an E and up

to a two-digit number (three digits on some machines) which indicate the power of 10 by which the preceding real fixed-point number should be multiplied to produce the correct order of magnitude. The power of 10 value, called the exponent, may be a signed number as well. Examples are as follows:

- 1.24E2 = 124.0
- -10.45E4 = -104500.0
- -45.63E-4 = -0.004563
- 3141592E-6 = 3.141592.

In the descriptions that follow, a real floating-point value is specified by using the FORTRAN editing code of Exx.xx, where the E stands for floating point, and the xx is a number indicating the length of the field that will contain the number. The xx that follows the decimal point indicates the number of decimal places that will be assumed if no decimal point is entered as follows.

- E10.2 - Real number in a field 10 digits long with an assumed decimal point two places from the right of the last digit. A number entered as 1024 or as 1.024E1 will be interpreted as the value 10.24.
- E10.0 - Real number in a field 10 digits long with no assumed decimal point. A number entered as 1024 will be interpreted as the value 1024.

All numbers entered must fit within the field specified, or erroneous results will occur.

Alphanumeric (character) data are often entered for titling purposes. These data consist of a string of characters of the users choice, not exceeding the input field length in number. Examples are as follows:

- THIS IS AN EXAMPLE TITLE 24 character string
- ANOTHER LINE 12 character string.

In the descriptions that follow, an alphanumeric value is specified by using the FORTRAN editing code of Axx, where the A stands for alphanumeric, and the xx is a number indicating the length of the field that will contain the characters. Examples are as follows:

- A10 - A field of 10 is available for character input. The characters may be entered anywhere within the field.

All characters entered must fit within the field specified, or erroneous results will occur.

4.0 INPUT PREPARATION

4.1 INTRODUCTION

Preparation of input for a MAGNUM-2D simulation consists of a series of interrelated but identifiable steps. These steps are as follows:

1. Construction of a suitably discretized geometric model that takes into account the materials comprising the various regions of the model
2. Definition of the initial and boundary conditions
3. Definition of the material properties
4. Definition of the program control parameters and time-step sequences.

While the following discussion will not follow these points in the order given, each item should be kept in mind to ensure that a complete data set representing the problem is developed.

The actual input data for MAGNUM-2D are entered in a very definite, controlled order. In some cases, data entered early in a data set control the type and quantity of data entered later. Care should be taken to ensure that the values entered in these cases are consistent, since errors of this nature can be difficult to pinpoint.

All the card types available to the user for input are presented and the parameters that are entered on each card are described in Section 4.2. A summary is given in Section 4.3 of the card types giving FORTRAN variable names, short definitions, field lengths, and input editing codes for easy reference during setup of simulation input. In both sections, the card types are given in order of their occurrence in an input stream.

4.2 INPUT DATA DESCRIPTION AND DISCUSSION

A detailed, in-depth description of each input parameter is given in this section. Numbers that appear in parentheses represent allowable values for some parameters that only have a limited number of choices.

Card Type A

Title Card

TITLE - This parameter is a string of up to 80 characters that may be input to describe the analysis. It is limited to one card. This parameter will be output as part of the header on the MAGNUM-2D printout.

Card Type B

Control Parameters

IMODE - This parameter flags whether the simulation being performed is time dependent (0) or steady-state (1). If steady state is indicated, the input for the dynamic control data below is still required but is ignored in the simulation. No convergence criteria are required.

Data files for transient runs can be used for steady-state runs without modifications. Reset variable IMODE from 0 to 1, and only one iteration will be taken. Time steps and thermal loads in the input file will be ignored.

ITEMP - This parameter indicates how the temperatures are handled or used. The options are to ignore heat flow calculations (0), to simulate heat flow (1), to uncouple the heat flow/fluid flow calculations (2), and to utilize temperature input without performing the heat flow analysis (-1).

If ITEMp = 0, the hydrodynamic flow equation is solved without any heat transfer. An initial run of the flow at steady state can be used to determine the initial conditions for transient runs.

If ITEMp = 1, a coupled thermal-flow simulation is performed. Incremental changes in the dependent variables, head and temperature, are solved by a system of simultaneous equations. The calculated thermal values are used to update the temperature-dependent coefficients in the conductivity matrix and in the load vector at each time step. The coupled simulation requires the most computer time because the matrix to be inverted is large, and it must be updated at each time step.

If ITEMp = 2, the thermal equation is uncoupled from the flow equation. This can save computer time. The flow equations are solved alone, and the head values are used to solve the thermal equations. At the next time step, the new temperature values are used to update the conductivity matrix and the load vector in the flow equation. The large matrix in the coupled simulation has been broken into two smaller matrices that are solved alternately, thus reducing the computation time.

If ITEMp = -1, MAGNUM-2D uses temperature results from a previous run. While thermal fields strongly affect the groundwater flow patterns, the thermal regime is only slightly influenced by the flow. Therefore thermal output from a previous simulation can be used repeatedly in a flow simulation sensitivity analysis.

IMOIST - This parameter indicates how fluid flow will be handled. The options are to simulate fluid flow (1), to ignore fluid flow (0), and to assume steady flow (2) at each time step.

If IMOIST = 0, the thermal equation is solved without fluid flow. All the thermal transport is by conduction through the rock with no advection.

If IMOIST = 1, a hydrodynamic simulation is invoked. The values of IMODE and ITEMP together determine the nature of the hydrodynamic simulation.

If IMOIST = 2, steady-state flow is computed at each time step, regardless of whether or not the temperature equation is being solved.

NP - This parameter indicates the number of node points needed to define the model used for the current simulation. It is used to control the geometry input later. This value should be entered properly even if the geometry is to be entered from an external geometry file. The nodal point count on the file is checked against it.

NE - This parameter indicates the number of elements needed to define the model used for the current simulation. Later, it is used to control the geometry input. This value should be entered properly even if the geometry is to be entered from a geometry file. The element count on the binary file is checked against it.

NMAT - This parameter indicates the number of different material or rock types that will be used in the model. Later, it is used to control the material data input.

ICND - This parameter indicates the type of initial conditions to be used for this simulation. Two choices are available. The first is to read one input record to define the initial conditions for all node points (0). The second is to read one record for each node (1). This parameter is used to control the type of input needed later.

If the initial conditions are unknown, one card can be used to define all nodes with the same initial value estimate, i.e., ICND = 0. In steady-state flow problems, the initial head values are unimportant because the algorithm calculates head values at the unknown nodes based on known boundary values. The first few time steps of a transient flow simulation, however, can be influenced by the initial head conditions, so a reasonable estimate is needed. A steady-state, flow only run, with variable ICND = 0 and file unit ICSV specified, can be used to generate and save head values. The ICSV file may then be used for initial condition input in a subsequent transient run.

In contrast, initial temperature values are important in both steady-state and transient heat problems. The density and viscosity are based on these reference values. One initial condition card can be used, but the temperature chosen should be representative of the system (alternatively, see TREF). If file unit ICSV is specified, the data from a steady-state, heat flow only simulation can be used as the initial conditions in a transient run.

Initial condition files can also be created by a preprocessor program ICGEN. The ICGEN or ICSV initial condition file must be inserted into the data deck at the appropriate location (see card type J). To signal that there is one initial condition card per node, set ICND = 1.

IECH - This parameter controls the echoing or parrotting of the input data. The choices are to echo only part of the data (0) or all the data (1).

If IECH = 0, the principal problem specifications, specified boundary conditions, rock hydraulic properties, and heat generation history will be printed in tabular form. If IECH = 1, the input geometry, initial conditions, and element connectivity will be printed in addition to the above default output.

IALL - This parameter controls the diagnostic printout available during the simulation. Either no printout is available (0) or a listing of data showing convergence may be obtained (1).

If IALL = 1, the maximum change in head or temperature is printed at each time step. Extremely large changes might indicate instability in the solution. The maximum change in state variables may also be used as a convergence criteria. If the value is close to zero for several time steps, the transient problem has probably reached steady state. This information is useful, e.g., in convection cell simulations with a constant heat source. The default of IALL = 0 provides none of the above output.

IVELP - This parameter controls the printout of the velocities at each Gauss point. The user may choose no printout (0) or printout for all the nodes (1). Regardless of the choice, the data will still be written to the binary velocity output file specified as IVEL.

IPRT - This parameter controls the frequency of output to the binary results file specified as ISV. The output may be generated at each time step (0), or at the print frequency specified below (1). A choice of (0) may result in a very large file being produced, since many time steps may occur for a simulation to finish and the data for each node will be written each time step. A choice of (1) will cause the output to the binary file to correspond to the printed output.

NSYS - This parameter controls the type of coordinate system to be used in defining the simulation model. The choices are Cartesian (0) or radial about the y axis (1).

Card Type C

File Assignments

The MAGNUM-2D computer code is designed to allow data to be read from or written to a mass storage device. To tell the program where to read or write, the user must provide the LUNs of the files that are being used.

Each system will have a slightly different way of associating LUNs with files so the system documentation should be consulted for advice on how to accomplish this. The default input unit (defined internally) is IC = 5, and the output unit is IOUT = 6.

IRS - This logical unit is used as the input file for restarting a simulation. The file should be the one specified as ICF (see below) in the previous run. Note that for restarting a simulation, all the data must be re-input, but some may not be used.

ISV - This logical unit is used to save the results of the simulation for later processing. It contains the heads and/or temperatures generated and is designed to be used by the various postprocessors available for MAGNUM-2D. The data is saved on this file at the time-step frequency specified by parameter IPRT discussed previously.

ICF - This logical unit is used to save the data necessary to restart the simulation at a later time. It is the file that is used as IRS when restarting.

IGI - This logical unit is used as input for the geometry that has been created using a preprocessor or has been saved (see below) from a previous simulation using the same model. This file may be a binary or coded file. If the initial attempt to read as a coded file fails, a binary read is used. Binary files are recommended to reduce I/O time.

IG - This logical unit is used to save the geometry defined in the current simulation for later use. It could be used as IGI (see above) when needed.

IVEL - This logical unit is used to save the data necessary for computing the velocity field. Its intended use is for the PATH program, but other postprocessors may also utilize it. The contents of this file are material properties (with corrections due to temperatures), density disparity, and head values at each time step.

The Darcy velocities can be calculated by interpolation at any interior point of an element. The sister program CHAINT uses this file as input to the solute transport simulation. Several postprocessor graphics programs use the IVEL file; e.g., the VELPLT program plots the velocity vector field, and the program PATH can be used to plot the streamlines or the pathlines of the flow field.

INPT - This logical unit is used as input for the temperature field generated by another simulation. Its format is the same as the ISV file (see above) allowing the results of an earlier temperature simulation to be used as input. MAGNUM-2D will use the precalculated temperatures in the INPT file for the current flow simulation. IMOIST must equal one when this option is used.

ICSV - This logical unit is used to save the final conditions of temperature and head calculated at the end of the current simulation as a coded file so that they can be edited into data for a later simulation. Refer to the parameter ICND when this data is to be used in a later run.

Card Type DConstants Definition

SSF - This parameter specifies the starting time for the simulation. It is typically set to 0.0. Restarted simulations will automatically start at the ending time of the previous run.

ALFA - This parameter specifies the weighting factor, θ , to be used in the simulation. It should be a value between 1 and 2, i.e., $1 < \theta < 2$. The time derivatives of the dependent variables are approximated by the difference expression (Eq. 15). When $\theta = 1$, the expression is a backward difference of the fully implicit kind with maximum damping. The Crank-Nicolson approximation is invoked when $\theta = 2$. A commonly used value for θ is 1.8.

TREF - This parameter specifies the reference temperature to be used when calculating the initial densities and viscosities from the reference density and viscosity respectively (as long as TREF > 0.05).

Using this parameter, the user may specify a reference temperature that is different than the starting temperature and correctly model the buoyancy/viscosity effects. The properties of viscosity and density are modeled as a one-dimensional Hermitian expansion as are the coupling coefficients. The temperature range is from 0.0-300.0 °C

Card Type EDynamic Control Card

This card type is used to specify the time-step information for the simulation. The total time for the simulation is broken into intervals that are arbitrary in length and are in turn further broken into equally sized time steps. This scheme for variation of time step size allows the user to tailor MAGNUM-2D to each problem. After perturbations occur in the model, small time steps allow adaptation to rapid changes. Larger time steps are adequate when the model response is slow.

NTS - This parameter specifies the number of time steps to be used in a specific time interval. Typically, the user would specify more time steps of shorter duration for those time intervals suspected of having more variation in the heads and/or temperatures.

NTSG - This parameter specifies the frequency at which the results of the simulation will be printed; i.e., every NTSG time steps a printout of the current results will be created. As an example, consider NTS = 25 and NTSG = 4. The results will be six printouts corresponding to the time steps 4, 8, 12, 16, 20, and 24.

DLT - This parameter specifies the actual time allotted to each time step. It is specified in years. As an example, consider the previous example of NTS = 25 and NTSG = 4. If DLT = 10.0, then the time interval will be 250 yr long (25 time steps of 10.0 yr each) and will have printout corresponding to 40, 80, 120, 160, 200, and 240 yr.

Card Type F

Control Factors

SCALEX - This parameter allows the user to apply a uniform scale factor to the x-dimensions of a model without having to modify the input data.

SCALEY - This parameter allows the user to apply a uniform scale factor to the y-dimensions of a model without having to modify the input data.

In order to decrease the amount of time needed to complete the simulation but maintain accuracy in the region of greatest variation, the elements in the mesh may be split into two groups by using the following parameters to define a zone. Within this zone, the elements will use a quadratic-shape function, while outside it, the elements will use a linear-shape function.

ZONEL - This parameter specifies the left boundary for the quadratic zone and is given in meters.

ZONER - This parameter specifies the right boundary for the quadratic zone and is given in meters.

ZONET - This parameter specifies the top boundary for the quadratic zone and is given in meters.

ZONEB - This parameter specifies the bottom boundary for the quadratic zone and is given in meters.

If these four parameters are entered as zeros or are left blank, the state variables will be approximated with quadratic-shape functions over all elements.

Card Type G

Element (connectivity) Definition

This card type should be omitted if a data file is being used for geometry input, i.e., if IGI is nonzero on card type C. The number of sets of the following parameters should correspond to the value entered for NE (number of elements) on card type B.

J - This parameter specifies the element number being entered. The element numbers are used as indices to arrays, so they must be contiguous starting with one, but need not be entered in any specific order.

NOP - This parameter specifies the node numbers that define the element. There may be up to eight nodes per element, and they must be entered counterclockwise starting from any corner node. If a quadratic-shape function element is being specified, all eight nodes must be entered. If only the four corner nodes are entered (with the midside node entries being blank or zero), then a linear-shape function element is assumed. If a triangular element is needed, it may be specified in a similar manner by entering six nodes for a triangular quadratic element or the three corner nodes (with blank or zero midside nodes) for a linear quadratic element. Line elements are entered in a similar fashion; the choices being either three nodes for a quadratic-shape function or two nodes for a linear-shape function. (See Section 3.2.)

IMAT - This parameter specifies the material type used for this element. It must correspond to one of the material types defined on the following type M cards.

NFIXH - This parameter specifies the order in which this element will be considered during the solution phase of the simulation. These values may be input by the user but are typically modified by one of the preprocessors which optimizes the model geometry.

Card Type H

Coordinate (Geometry) Definition

This card type should be omitted if a data file is being used for geometry input, i.e., if IGI is nonzero on card type C. The number of sets of the following parameters should correspond to the value entered for NP (number of node points) on card type B.

N - This parameter specifies the number of the node being entered. Like the elements, the nodes need not be entered sequentially; but node numbers must be contiguous and start with one.

CORD(N,1) - This parameter specifies the x-coordinate of the node in global coordinates.

CORD(N,2) - This parameter specifies the y-coordinate of the node in global coordinates.

Card Type J

Initial Condition Definition

The use of this card type is controlled by the variable ICND, which was entered on card type B. Two modes of use exist. If ICND = 0, a single card of this type is used to define the initial conditions for head and/or

temperature for every node in the model. If ICND = 1, MAGNUM-2D expects to find one initial condition card, as described here, for each node in the model.

Note that if a restart simulation is being performed, the initial condition specification must be present for the restart run to be valid.

N - This parameter specifies the node for which the initial condition is being entered. This parameter is ignored if ICND = 0.

T1 - This parameter specifies the temperature to be used initially for the node(s) in question. It is entered in degrees Celsius.

T2 - This parameter specifies the hydraulic head to be used initially for the node(s) in question. It is entered in meters.

Card Type K1

Dirichlet Boundary Condition Nodes

A zero flux Neumann condition is assumed at all unspecified boundary nodes.

KSPEC - This parameter specifies the number of nodes at which constant head and/or temperature boundary conditions will be specified.

Card Type K2

Dirichlet Boundary Condition Values

The number of sets of the following parameters is controlled by the value entered for KSPEC above. One set is entered for each node at which a boundary condition is to be specified.

N - This parameter specifies the node number at which the boundary condition is being specified.

NFIX - This parameter specifies the type of boundary conditions being specified. It consists of a two-digit integer number that may have a one entered in either place. A one entered in the tens place indicates that a temperature value is being entered while a one in the ones place indicates that a hydraulic head value is being entered.

BVAL(1) - This parameter specifies the actual boundary condition value to be used for temperature at the node in question. It is specified in degrees Celsius.

BVAL(2) - This parameter specifies the actual boundary condition value to be used for hydraulic head at the node in question. It is specified in meters.

As an example of the boundary condition specifications, consider the following example card images:

13	10	103.	11.
28	01		5.7
57	11	95.	10.6

The first entry specifies the boundary condition for Node 13 as temperature only (10), indicating a value of 103.0 °C. The second entry specifies the boundary condition for Node 28 as head only (01) with a value of 5.7 m. The last entry specifies the boundary conditions for Node 57 as, temperature and head (11), 95.0 °C and 10.6 m, respectively.

Note that in the first entry, even though a value is entered for head or temperature (in this case head), unless the appropriate flag is set, that value will be ignored.

Card Type M Material Properties

This card type set defines the properties of the materials comprising the model(a). The number of material properties to be specified was entered on card type B as NMAT. Each entry must consist of two cards, so the number of material property definition cards must be NMAT*2. Note that some of the properties are anisotropic. If this capability is not required, specify the property to be the same in both directions.

The Card 1 parameters are as follows.

L - This parameter specifies the material type number. This is the number referred to in the element definition as IMAT.

CVM - This parameter specifies the specific heat of the rock, C_s , for this material type in joules per kilogram-degree Celsius [J/(kg·°C)].

TKK(L,1) - This parameter specifies the thermal conductivity of the rock in the x-direction, D_{sx} , for this material type in joules per second-meter-degree Celsius [J/(s·m·°C)].

TKK(L,2) - This parameter specifies the thermal conductivity of the rock in the y-direction, D_{sy} , for this material type in joules per second-meter-degree Celsius [J/(s·m·°C)].

(a) In this context material properties are synonymous to rock properties in that the saturating fluid is assumed to be water and the reference water properties are hard coded with the following values: $\rho^* = 985 \text{ kg/m}^3$, $c_f = 4174 \text{ J/(kg·°C)}$, $D_f = 2.008 \times 10^7 \text{ J/(m·yr·°C)}$, and the compressibility of water is $4.6 \times 10^{-10} \text{ Pascals}$.

POROS(L) - This parameter specifies the effective porosity, ϕ , of the rock for this material type. It is a dimensionless number.

HKAX - This parameter specifies the hydraulic conductivity in the x-direction, K_{xx} , for this material type in meters per second (m/s).

HKAY - This parameter specifies the hydraulic conductivity in the y-direction, K_{yy} , for this material type in meters per second (m/s).

NME - This parameter may be used to assign a name to this rock type. It is optional and may be up to eight characters in length. It is printed with the echoed data.

The Card 2 parameters are as follows.

SP1 - This parameter specifies the specific storage, S_s , of this material type. Its units are 1/m.

RHOM - This parameter specifies the bulk density, ρ_s , of this material in kilograms per cubic meter (kg/m^3).

ALPAL - This parameter specifies the longitudinal dispersivity, α_L , of this material in meters (m).

ALPAT - This parameter specifies the transverse dispersivity, α_T , of this material in meters (m).

WIDTH - This parameter specifies the thickness or width of fractures, e , used in the model. It is used only for fracture elements and must be zero for continuum elements. It is specified in meters (m).

Card Type P

Thermal Loading Control

This card type must exist for every simulation. If no thermal loads are applied, this is indicated using the parameter NLD as described below. Flow only simulations automatically ignore any thermal data.

Note also that no thermal loads are allowed for a steady-state run. An ill-formed problem may result if this is attempted.

NLD - This parameter specifies the number of elements in the model that will be considered as heat source elements. If no thermal loads are to be applied to the model, this parameter should be entered as a zero or a blank card.

NLT - This parameter specifies the number of thermal load data points, i.e., the number of times and corresponding loads that will be input. This parameter is ignored if NLD = 0 above. For a transient problem, if NLT = 0, a piecewise exponential decay will be applied to the single initial thermal load defined on card type R1 below. The decay function is given in Equation 19. In this case FORTRAN variable QT contains the current source strength.

SCF - This parameter specifies a scale factor that is applied to the thermal load values. This parameter is ignored if NLD = 0 above.

Card Type 0

Heat Source Elements

This card type is ignored if NLD = 0 on card type P.

NLE(I) - This parameter specifies the element numbers of the elements that are to be considered as the heat sources in the model. The number of these elements is controlled by the parameter NLD on card type P above. Each record (or line) may contain at most 16 fields, and the records may be repeated as many times as needed.

Card Type R1

Initial Thermal Load Definition for Exponential Decay

This card type is ignored if NLD = 0 on card type P, and is only used if NLT = 0 and NLD ≠ 0.

Q0 - This parameter specifies the initial thermal load, Q°, to be used for the exponential decay for all the elements entered in card type Q. It is given as joules per year-cubic meter [J/(yr·m³)].

Card Type R2

Thermal Load Definition

This card type is ignored if NLD = 0 on card type P, and is only used if NLT ≠ 0 and NLD ≠ 0.

The loading is specified by defining a set of points in time at which the thermal load is known. The range of times input must bracket or coincide with the range covered by the simulation. Any times used by the simulation but not input are interpolated as long as the input times bracket the time required. Thus, this interpolation requires that a minimum of two time/load pairs be input.

TLE(I) - This parameter specifies the time of the thermal load being entered for the next parameter. It is given in years (yr).

QLE(I) - This parameter specifies the thermal load for the time entered above in joules per year-cubic meter [J/(yr·m³)].

These time and load values are input in pairs, up to four per card, until NLT values have been entered. Recall that NLT was defined as the number of thermal loads on card type P above. Repeat this card type as many times as needed.

4.3 INPUT DATA FORMAT SUMMARY

Card Type A

Title Card

1-80 TITLE 20A4 Title or description of this analysis, up to 80 characters.

Card Type B

Control Parameters

01-05 IMODE I5 Simulation Mode
 = 0 Time-dependent analysis.
 = 1 Steady-state analysis.

06-10 ITEMP I5 Temperature Option
 = 0 No heat flow in this analysis.
 = 1 Temperature simulation.
 = 2 Temperature simulation uncoupled from fluid flow (i.e., $q_i \frac{\partial T}{\partial x_i} = 0$).
 = -1 Temperature input from external file.

11-15 IMOIST I5 Fluid Flow Option
 = 0 No fluid flow simulation.
 = 1 Fluid flow simulation.
 = 2 Steady-state flow simulation at each time step.

16-20 NP I5 Number of Nodes in the Model

21-25 NE I5 Number of Elements in the Model

26-30 NMAT I5 Number of Rock Types in the Model
 (Number of Material Types)

31-35 ICND I5 Initial Condition Type
 = 0 Read only one card to define ICs.
 = 1 Read one card per node to define ICs.

36-40 IECH I5 Input Data Echo Switch
 = 0 Echo selected portion of the input data.
 = 1 Echo all the input data.

41-45 IALL I5 Diagnostic Printout
 = 0 Display no diagnostics.
 = 1 Print diagnostics regarding convergence.

46-50	IVELP	I5	Velocity Print Control (IMOIST ≠ 0 only) = 0 Do not print velocities. = 1 Print velocities.
51-55	IPRT	I5	Binary Results File (ISV) Creation Flag = 0 Write at each time step. = 1 Write at the print frequency requested by the user (NTSG below).
56-60	NSYS	I5	Coordinate System Control = 0 Cartesian coordinate system used. = 1 Radial coordinate system used (radial about the X = 0 line: Y axis).

Card Type C

File Assignments

01-05	IRS	I5	Restart input data file (generated by an earlier MAGNUM-2D run).
06-10	ISV	I5	Binary results file (contains head and temperature results for each node in the model).
11-15	ICF	I5	Restart output data file (to be generated for use by a later MAGNUM-2D run).
16-20	IGI	I5	Geometry input file (optional and supersedes the geometry input parameters requested later).
21-25	IG	I5	Geometry output file. The input geometry data is written to this binary file for subsequent use.
26-30	IVEL	I5	Velocity output file. This binary file may be used as input for the PATHLINE program (see the appendixes for more information) or other postprocessing.
31-35	INPT	I5	Temperature input file.
36-40	ICSV	I5	Initial condition output file. The state of the simulation is written (in coded form) to this file for subsequent use as an initial condition file.

Card Type D

Constants Definition

01-10	SSF	F10.1	Initial time, t^o (in yr).
11-20	ALFA	F10.1	Weighting factor ($1 < \theta < 2$).
21-30	TREF	F10.1	Temperature for computing reference densities and viscosities. Set TREF = 0.0 to use initial temperature distribution, instead of TREF.

Card Type E

Dynamic Control Card

(This card is repeated as needed.
Terminate this card type set with
NTS=9999.)

01-05	NTS(I)	I5	Number of time steps.
06-10	NTSG(I)	I5	Printout frequency.
11-20	DLT(I)	F10.1	Time steps in years.

Card Type F

Control Factors

01-10	SCALEX	F10.1	Scale factor for the x-coordinates.
11-20	SCALEY	F10.1	Scale factor for the y-coordinates.
21-30	ZONEL	F10.1	Left boundary for quadratic element generation zone.
31-40	ZONER	F10.1	Right boundary for quadratic element generation zone.
41-50	ZONET	F10.1	Top boundary for quadratic element generation zone.
51-60	ZONEB	F10.1	Bottom boundary for quadratic element generation zone.

Card Type G

Element (connectivity) Definition

The number of cards for this card type set is controlled by the parameter NE defined earlier. OMIT this card type set if a geometry input file is used, i.e., if IGI is NOT equal to zero.

01-05	J	I5	Element number.
06-45	NOP(J,K)	8I5	Up to eight node numbers for elements listed counterclockwise.
46-50	IMAT(J)	I5	Element type (material type). The number entered must correspond to one of the parameters specified as L under card type M below.
51-55	NFIXH(J)	I5	Element ordering array. This parameter is the number of the Jth element to process and may be used to optimize the solution of the matrix equations by modifying the bandwidth.

Card Type H

Coordinate (Geometry) Definition

The number of cards for this card type set is controlled by the parameter NP defined earlier. OMIT this card type set if a geometry input file is used, i.e., if IGI is NOT equal to zero.

01-05	N	I5	Node number.
06-17	CORD(N,1)	F12.3	x-coordinate (in m).
18-29	CORD(N,2)	F12.3	y-coordinate (in m).

Card Type J

Initial Condition Definition

01-10	N	I10	Node number (not used if ICND = 0 as discussed earlier on card type B).
11-20	T1	F10.1	Temperature (in °C)).
21-30	T2	F10.1	Hydraulic head (in m).

Note that if ICND = 0, only one card of this type is required. It will define the initial head and temperature at all nodes. If ICND = 1, then, NP cards of this type must be supplied (one for each node).

Card Type K1

Dirichlet Boundary Condition Nodes

01-05	KSPEC	I5	Number of nodes at which boundary conditions will be specified.
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<u>Card Type K2</u>		Dirichlet Boundary Condition Values	
01-10	N	I10	Node number.
19-20	NFIX	I2	Specified value node type indicator. This is a two-digit number, where the tens place represents temperature, and ones place represents hydraulic head. 0 = >unspecified, 1 = >specified.
21-30	BVAL(1)	F10.1	Specified temperature (in °C).
31-40	BVAL(2)	F10.1	Specified hydraulic head (in m).

<u>Card Type M</u>		Material Properties.	
		There will be twice NMAT cards in this card type set where NMAT was defined earlier on card Type A as the number of material types.	
01-10	L	I10	Material type number.
11-20	CVM	F10.1	Specific heat, C [in J/(kg·°C)].
21-30	TKK(L,1)	F10.1	Thermal conductivity in the x-direction, D_{sx} [in J/(s·m·°C)].
31-40	TKK(L,2)	F10.1	Thermal conductivity in the y-direction, D_{sy} [in J/(s·m·°C)].
41-50	POROS(L)	F10.1	Effective porosity, ϕ (fraction).
51-60	HKAX	F10.1	Hydraulic conductivity in the x-direction, K_{xx} (in m/s).
61-70	HKAY	F10.1	Hydraulic conductivity in the y-direction, K_{yy} (in m/s).
73-80	NME	A8	Material type name identifier (optional).

Begin the Second Card

11-20	SP1	F10.1	Specific storage, S_s (1/m).
21-30	RHOM	F10.1	Bulk density, ρ_s (in kg/m³).
31-40	ALPAL	F10.1	Longitudinal dispersivity, α_L (in m).

41-50	ALPAT	F10.1	Transverse dispersivity, α_T (in m).
51-60	WIDTH	F10.1	Fracture thickness (in m).

Card Type P

Thermal Loading Control

This card type must be entered whether thermal loading is being specified or not.

01-05	NLD	I5	Number of heat source elements. NLD = 0 indicates that no loading will occur.
06-10	NLT	I5	Number of thermal load points to be specified. Ignore if NLD = 0.
11-20	SCF	F10.2	Scale factor. Ignore if NLD = 0.

Card Type Q

Heat Source Elements

Omit this card type if parameter NLD = 0 on card type P.

01-80	NLE	I5	Element number to which heat sources are applied (16 values may be entered on a single card). There must be NLD values entered where NLD was defined on the previous card. This card type may be repeated as many times as needed.
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Card Type R1

Thermal Load Definition

Omit this card type if parameter NLD = 0 on card type P.

01-10	Q0	F10.0	Initial thermal load, Q^0 [J/(yr·m ³)].
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Card Type R2

Thermal Load Definition

Omit this card type if parameter NLD = 0 on card type P.

01-10	TLE(1)	F10.0	Time of thermal load, t^1 (yr).
11-20	QLE(1)	F10.0	Thermal load at this time, Q^1 [J/(yr·m ³)].

21-30	TLE(2)	F10.0	Time of second thermal load point, t^2 .
31-40	QLE(2)	F10.0	Thermal load, Q^2 , at the time t^2 .
41-80			Continue entering time and load input in pairs, up to four per card, until NLT values have been entered. Repeat this card type as many times as needed. NLT was defined as the number of thermal loads on card type P above.

5.0 OUTPUT

5.1 INTRODUCTION

The output from the MAGNUM-2D program is available in two forms. The first is the printed output that reports on the input data, the parameters that were set, the events that took place during execution, the heads and temperatures calculated at the various time steps, the duration of the run (in model time), and so on. The second form of output is composed of the various binary data files that are created for use by postprocessing programs and further analysis by other simulation programs such as CHAINT. This section will give an overview and some explanation of the printed report and the possible use of each of the binary files.

5.2 PRINTED REPORT

The MAGNUM-2D program generates one printed report file. The contents of this report may be modified by the input data using the parameters IECH, IALL, and IVELP, which appear on card type B. These parameters are described in Sections 4.2 and 4.3. Their effects will be pointed out in the following discussion.

For examples of the output report, see Appendix D.

5.2.1 Banner Page

The formatted report begins with a banner page that announces (1) the version and revision of MAGNUM-2D, (2) the day, date, and time of the run that generated the printout, and (3) the unique identifier assigned to the run. This identifier is placed on all the mass storage files and is displayed by the graphics postprocessors. It acts as an "audit" trail, allowing the user to ensure a match between printout and graphic results.

5.2.2 Input Verification

The next section of the output is the input verification section, which is divided into output "Tables." Note that in the output tables, temperature and head values are given in degrees Celsius and meters, respectively. As a reminder, column headers are T(C) for temperature and H(M) for head.

The "PRINCIPAL PROBLEM SPECIFICATIONS" are printed in output Table 1. This is an echo of the parameters input on card types B, C, F, D, and E. The card types are echoed in the order just given, and the parameters on each card type are echoed in the input order (see Section 4.2).

The "NODE POINT COORDINATES" are printed in output Table 2: This is an echo of the node point locations as defined for the problem. It is simply a table of node numbers and the corresponding x- and y-coordinates. This table is not produced if IECH = 0.

The "ELEMENT/NODE CONNECTIVITY" is printed in output Table 3. This is an echo of the connectivity defined for the problem, e.g., the node numbers that define the corner and midside nodes of the elements defining the model. It is simply a table of element numbers and the corresponding node numbers that define the element (up to the maximum of eight nodes). These are given in the order that MAGNUM-2D encountered them. Note that the table also includes the rock type and the order used in solving the matrix equations. (This may be modified or defined manually or by using a geometry preprocessor such as MESHER.) This table is not produced if IECH = 0.

The "INITIAL CONDITIONS" are printed in output Table 4. This is an echo of the initial conditions defined by the user or generated by MAGNUM-2D at the request of the user on card type J. It consists of a list of the node numbers at which the initial conditions are defined, and the temperature and head values are specified at those nodes. This table is not produced if IECH = 0.

The "SPECIFIED BOUNDARY CONDITIONS" are printed in output Table 5. This is an echo of the Dirichlet boundary conditions input on card type K1 and K2. It contains the node at which the boundary condition is applied, the type (using the same code as specified on input for temperature, head, or both), and the temperature and head input.

The "ROCK PROPERTIES" are printed in output Table 6. This is an echo of the properties input on card type M. The entries in this table are arranged in a two-dimensional array. The rows represent the actual properties (identified by name and units), and the columns represent the various rock or material types (identified by number and by user defined name).

The "HEAT GENERATION HISTORY" is printed in output Table 7. This is an echo of the thermal loading and heat source information input on card types P, Q, and R. The card types are echoed in the order just given, and the parameters on each card type are echoed in the input order (as described in Section 4.2).

5.2.3 Simulation Results

The title entered by the user on card type A is printed in the upper left corner of each page of simulation results. The next line announces the results time in years, or that the results are for steady state. The table that follows gives the head and/or temperature values for each node point in the model. The user will note asterisks occurring beside some of the head/temperature values. These mark the specified boundary conditions.

If the user specified IALL = 1 diagnostic output will be printed. This consists of some convergence criteria, namely, the iteration number, the maximum change in the temperature/head value, and the maximum relative correction made.

When MAGNUM-2D reaches a time step for which velocity output has been requested and IVELP = 1, the velocity results are printed. This output takes the form of a two-dimensional matrix with the rows representing the elements (with the x and y velocities as subdivisions) and the columns representing the Gauss points.

5.2.4 Gauss Point Locations

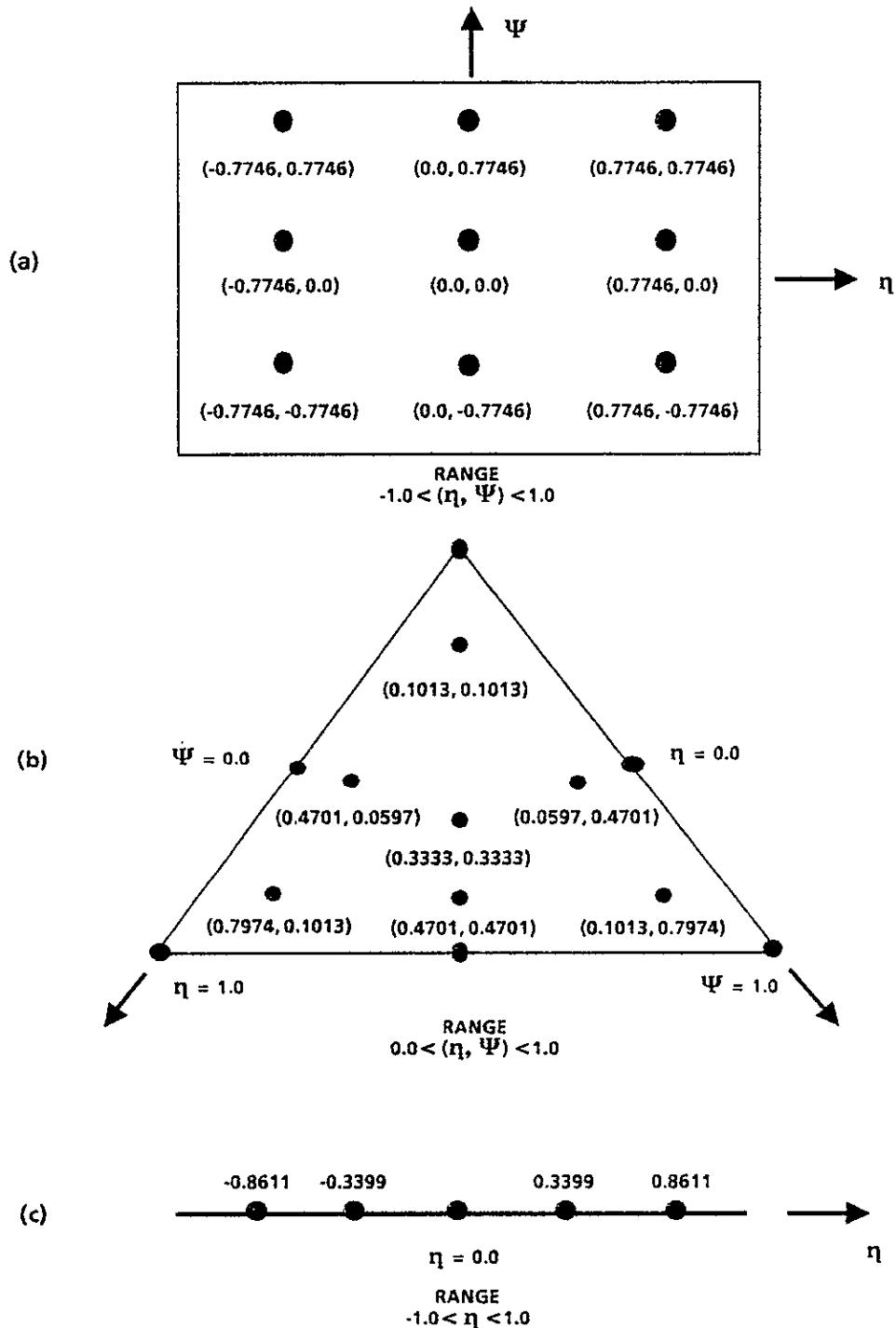
Occasionally, it is necessary to consider the velocity distribution within a single element. Because the velocities are computed from heads interpolated to the Gauss points, the Gauss point locations are of interest. The location of the points in the three element types and their numbering relative to the node point numbering order are shown in Figures 1 and 2.

The actual location of each of the Gauss points is given in Figure 4 for the case of quadratic-shape functions.

5.3 OTHER OUTPUT FILES

The input/output file LUNs are all specified on card type C, "File Assignments." The parameters associated with output files are ISV, ICF, IG, IVEL, AND ICSV. The use of some of these files may be clarified by the data flow diagrams in Appendix A. Each of the above files is a binary file, except as noted otherwise.

ISV MAGNUM-2D Flow and Temperature File. It contains both the head and temperature values at each node for each user-specified time step. This data may be used to generate contours, time-histories, and spatial cross sections.



PS84-2131-4

FIGURE 4. Gauss Points in Local Coordinates η, ψ for (a) Quadratic Quadrilateral, (b) Quadratic Triangle, and (c) Quadratic Line Elements.

- ICF MAGNUM-2D Restart Data File. It contains all the necessary data needed to restart the simulation from the time step at which the file was produced. When MAGNUM-2D is flagged to produce this file, it will indicate that the restart file was generated by printing a message to that effect after the head and temperature printout. The time step at which this message is printed is the time step at which the restarted run will commence.
- IG MAGNUM-2D Geometry File. This file is a convenience only. It allows the user to save the geometry on a mass storage file for later use if, for instance, the original input was on cards or some other media. This file is simply a geometry file and may be used in the same fashion as any file that had been created using preprocessors.
- IVEL MAGNUM-2D Velocity File. It contains the velocity data in binary form. This file may be utilized by the CHAINT program for radionuclide solute transport. It may also be used by the postprocessor programs VELPLT to plot the velocity vectors, or PATH to plot pathlines or streamlines.
- ICSV MAGNUM-2D Initial Condition File. It contains the information necessary to define, as initial conditions, the state of every node in the model at the end of the current simulation. This file is a coded or ASCII file and may be used in an editing session to generate the input data for a later simulation.

6.0 NOMENCLATURE

<u>Symbol</u>	<u>Interpretation</u>	<u>Units</u>
s_s	Specific storage of rock	l/m
h	Hydraulic head	m
t	Time coordinate	yr
K	Hydraulic conductivity of rock	m/s
x, y	Global space coordinates	m
δ_b	Density disparity in rock	--
δ_{ij}	Kronecker delta	--
γ	Thermal coupling coefficient	1/°C
T	Temperature	°C

<u>Symbol</u>	<u>Interpretation</u>	<u>Units</u>
ρ	Fluid density	kg/m ³
ρ_0	Initial density	kg/m ³
ρ^*	Reference density	kg/m ³
ϕ	Effective porosity	--
B	Bulk modulus of fluid	1/°C
S_f	Specific storage of fracture	1/m
K_f	Hydraulic conductivity of fracture	m/s
L	Local coordinate of fracture	m
δ_b	Density disparity in fracture	--
g	Acceleration due to gravity	m/s ²
e	Fracture aperture	m
ν	Viscosity	m ² /s
S_t	Bulk heat capacity	J/(kg·°C)
c_f	Specific heat of fluid	J/(kg·°C)
q	Component of specific discharge	m/s
D_t	Effective thermal diffusivity	J/(m·s·°C)
Q	Thermal source	J/(kg·s)
ρ_s	Density of rock	kg/m ³
c_s	Specific heat of rock	J/(kg·°C)
D_f	Thermal conductivity of fluid	J/(m·s·°C)
D_s	Thermal conductivity of rock	J/(m·s·°C)
α	Dispersivity	m
\bar{q}	Groundwater speed	m/s

<u>Symbol</u>	<u>Interpretation</u>	<u>Units</u>
F	Generalized state variable	--
NP	Total number of nodes	--
z	Normal coordinate	m
w	Shape function	--
e	Residual	--
X	Galerkin functional	--
E	Finite element	--
θ	Weighting factor	--
ΔF	Incremental change in F	--
b	Heat generation coefficients	--
S	Generalized storage coefficient	--
Γ	Generalized conductivity	--
Δx	Internodal distance	--
Δt _{ch}	Characteristic time	--
η,ψ	Local coordinates	m

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APPENDIX A

PROGRAM INTERNALS

INTRODUCTION

MAGNUM-2D is written in FORTRAN 77 and is currently operational on the Basalt Waste Isolation Project PRIME 750 computer system. Earlier development work was performed on a UNIVAC 1100/40, and an early version was converted to a CRAY 1. Attempts were made to use standard FORTRAN 77, but some PRIME specific functions were used in isolated incidents. These will be pointed out in the following sections.

SUBROUTINES: FUNCTIONAL DESCRIPTIONS

This subsection lists the modules comprising the MAGNUM-2D program and gives a brief explanation of the function of each.

- | | |
|-----------|--|
| MAGNUM-2D | The main program that controls the simulation by calling the appropriate subroutines. The MAGNUM-2D program initiates the solution for each time interval. For transient solutions, the dependent variables and their gradients are predicted for the next time step. The flow and temperature file, the initial condition file, and the restart data file are written in this module. |
| BANNER | Prints a banner page including the date and time at which the run is initiated. This subroutine also generates the unique run identifier. |
| INPUTS | Reads control option parameters, file unit assignments, time step parameters, scale factors, geometry data, initial and boundary conditions, and material properties. |
| ZONE | Determines the pointer array which designates midside modes that are to be eliminated from computation. Mixed-order triangular or quadrilateral elements are constructed in transition zones. |
| LOADQ | Reads and/or computes the thermal loading rate for the source elements. |
| HEADR | Writes file headers to external files and reads the header record from the temperature input file, if specified. |
| SETUP | Sets up a pointer array for the element matrix and computes the total array storage requirement. |
| FPROP | A one-dimensional Hermitian polynomial expansion is used to approximate values of the viscosity, density, and coupling coefficient as functions of temperature. |
| VPROP | Computes density disparity and temperature correction to hydraulic conductivity. |

FRONT Performs a Gauss elimination procedure with partial pivoting using a frontal solution method for unsymmetric matrices.

STIFF Forms the coefficient matrices for each finite element. Gaussian quadrature is used to numerically integrate the element equations.

RESOL Performs the back substitution for the updated right-hand sides. The algorithm is based on the frontal solution approach.

RIGHTSD Forms the right-hand side load vectors which take into account updated coefficients and source terms.

VEL Computes the Darcian velocity at the Gauss points from the hydraulic head and conductivity values. The velocities are written to the velocity file by this subroutine.

WRT Performs mass transfer of pivotal rows to the scratch file according to a flag. Calls subroutine RWND (rewind file), POSIT (position file), and BINOUT (write file).

RED Reads pivotal row from scratch file for back substitution with mass transfer of data. Calls subroutines POSIT (position file) and BININ (read file).

RWND A subroutine using PRIMOS calls to rewind the scratch file.

POSIT A subroutine using PRIMOS calls to position the file pointer relative to the current location.

BININ A subroutine using PRIMOS calls to read variable length binary records from disk.

BINOUT A subroutine using PRIMOS calls to write variable length binary records to disk.

PRINT Prints out the tabular results for temperature and hydraulic head at each nodal point. Specific boundary values are indicated in the output by an asterisk. If required, this subroutine also prints out the velocities.

BLKDAT A block data routine that contains shape function and derivative evaluations at the Gauss points within the elements. The data statements contain evaluations specific to Gaussian quadrature formulas based on 2 x 2 Gauss points for linear-shape functions and 3 x 3 Gauss points for quadratic-shape functions.

PARA This is an insert file containing the parameter statements used to define the program limits. See the next section for details.

PROGRAM LIMITS

All arrays that would need to be changed due to a need to increase the model size are dimensioned using "PARAMETER" statements. If required, the maximum limits can be increased or decreased by changing these parameters within the insert file PARA and recompiling the program. Note that PARA contains images that are included or inserted in a subroutine at compilation time. Most systems have such a facility. In PRIMOS, it is the FORTRAN "INSERT" directive.

The following parameters are used in MAGNUM-2D:

MAXE	Maximum number of elements
MAXP	Maximum number of node points
MAXMAT	Maximum number of material types
MAXH	Maximum number of heat source elements
MAXT	Maximum number of points used to define a heat generation profile
NMAX	Maximum front width of equation network array
NTT	Maximum number of time intervals
MAXP2 = (MAXP * 2)	Maximum number of unknown dependent variables in R1 array, i.e., change in hydraulic head and temperature at each node.

The arrays affected by the PARAMETERS listed are given below with the names of the COMMON blocks in which they reside:

	COMMON /BLK1/
DLT(NTT)	Time-step size for each time interval
NTS(NTT)	Number of time steps in each time interval
NTSG(NTT)	Print frequency within each time interval
TIME(NTT)	Time at the end of each time interval

COMMON /BLK2/

CORD(MAXP,2)	x- and y-coordinates for each node
IMAT(MAXE)	Material type of each element
NBC(MAXP2)	Equation number for computational nodes
NFIXH(MAXP)	Element ordering array
NOP(MAXE,8)	List of element - node connectivity

COMMON /BLK3/

R1(MAXP2)	The change in state variables solved for at each node
-----------	---

COMMON /BLK5/

ALPAL(MAXMAT)	Longitudinal dispersivity (m)
ALPAT(MAXMAT)	Transverse dispersivity (m)
BETA(MAXP)	Thermal coupling coefficient
CVM(MAXMAT)	Specific heat of the rock [J/(kg·°C)]
HKAX(MAXMAT)	Hydraulic conductivity in the x-direction (m/s)
HKAY(MAXMAT)	Hydraulic conductivity in the y-direction (m/s)
POROS(MAXMAT)	Effective porosity
Q(MAXE)	Thermal loads in the domain [J/(yr·m ³)]
RHOM(MAXMAT)	Rock density (kg/m ³)
SP1(MAXMAT)	Rock specific storage (l/m)
ST(MAXMAT)	Heat capacity of the water-rock system [J/(m ³ ·°C)]
THETA(MAXE)	Conductivity corrections based on the change in viscosity
TKK(MAXMAT,2)	Thermal conductivity in the x- and y-directions [J/(s·m·°C)]
VISCO(MAXP)	Viscosity at the previous step

VISCA(MAXP)	Viscosity at the current step
WIDTH(MAXMAT)	Fracture aperature (m)
BOUY(MAXP)	Density disparity term
RHO0	Water density at previous time step
RHOA(MAXP)	Current water density

COMMON /BLK10/

KIND(MAXE,4)	Element type: quadrilateral, triangle, or line
MIDB(MAXP)	Midside or corner node flag

COMMON /BLK17/

TDOT1(MAXP,2)	Head and temperature derivatives two time steps back
TNXT(MAXP)	Temperature input values from a separate run file
TOLD1(MAXP,2)	Head and temperature values two time steps back

COMMON /BLK18/

TDOT(MAXP,2)	Head and temperature derivatives for the current time step
TDOTO(MAXP,2)	Head and temperature derivatives for the previous time step
TNEW(MAXP,2)	Head and temperature values for the current time step
TOLD(MAXP,2)	Head and temperature values for the previous time step.

FILE MANIPULATION

All mass storage files used by MAGNUM-2D are referenced internally by their logical unit numbers (LUN). Each operating system has its own way of associating the LUN with the files needed or being created by an application

program. For this reason, the user is asked to consult the operating system reference publications for the machine being used. The remainder of this section will be aimed at the PRIME operating system (PRIMOS).

PREASSIGNED LOGICAL UNIT NUMBERS

All the files except three are associated with, or may be associated with, a file previously generated, or that will be generated, by MAGNUM-2D. The first exception is LUN 16, which is used as the "out-of-core" solution scratch file. This file must be opened but is for scratch purposes only. The second and third exceptions are LUN 5 and LUN 6 (internal variables IC=5 and IOUT=6), which are used for the main input file and printed output file, respectively. That is, all the information discussed in Section 4.2 enters MAGNUM-2D via LUN 5, and all reports of the results of the analyses are printed via LUN 6. Variables IC and IOUT are set in the main program and are passed through common block INOUT where needed.

THE PRIMOS FILES

In PRIMOS the LUNs are associated with the appropriate files by using the OPEN command. It should be noted that the PRIME version OF MAGNUM-2D requires special attention to the assignment and use of LUNs. The numbers used in Section 4.2 for card type B are the FORTRAN LUNs. These have a range starting with one and going to some maximum value (consult the current PRIME FORTRAN manual). These numbers are decimal numbers. The PRIMOS LUNs, however, are octal numbers and have an offset of four relative to their FORTRAN counterparts. The following table shows the arrangement.

FORTRAN (decimal)	PRIMOS (octal)
1	user terminal
2	paper tape
3	card reader
4	serial printer
5	1
6	2
7	3
8	4
9	5
10	6
11	7
12	10
13	11
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Note that the arrangement shown means that the FORTRAN LUNs 5 and 6, for example, correspond to the PRIMOS LUNs 1 and 2, respectively.

SUBROUTINES: CONTROL AND HIERARCHY

A top level flowchart for the MAGNUM-2D program is shown in Figure A-1. In this figure the rectangular boxes denote subroutines, and the triangular boxes denote decisions. The flowchart depicts iteration in the solution at each time step; however, since applications of the code have never required more than a single iteration, the iteration limit is currently set to one. The full module hierarchy for the MAGNUM-2D program is depicted in Figure A-2.

CODE AVAILABILITY

The FORTRAN source code for MAGNUM-2D is not duplicated here for the sake of compactness, but it is available in the form of a paper listing and/or magnetic tape. Inquiries regarding MAGNUM-2D and requests for copies of the code should be directed to:

Mr. R. G. Baca
Rockwell Hanford Operations
Basalt Waste Isolation Project
Performance Assessment Group
P.O. Box 800
Richland, Washington 99352

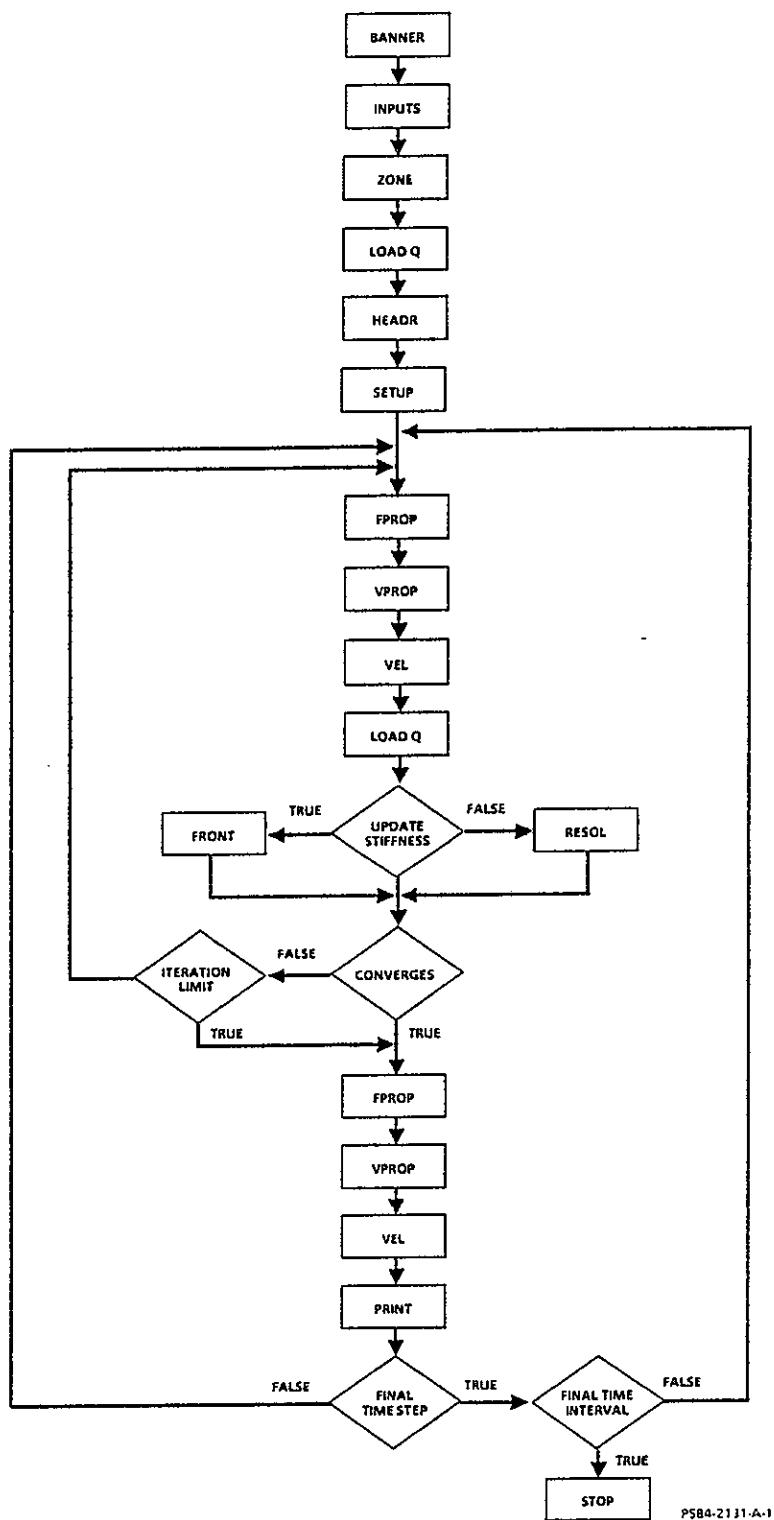
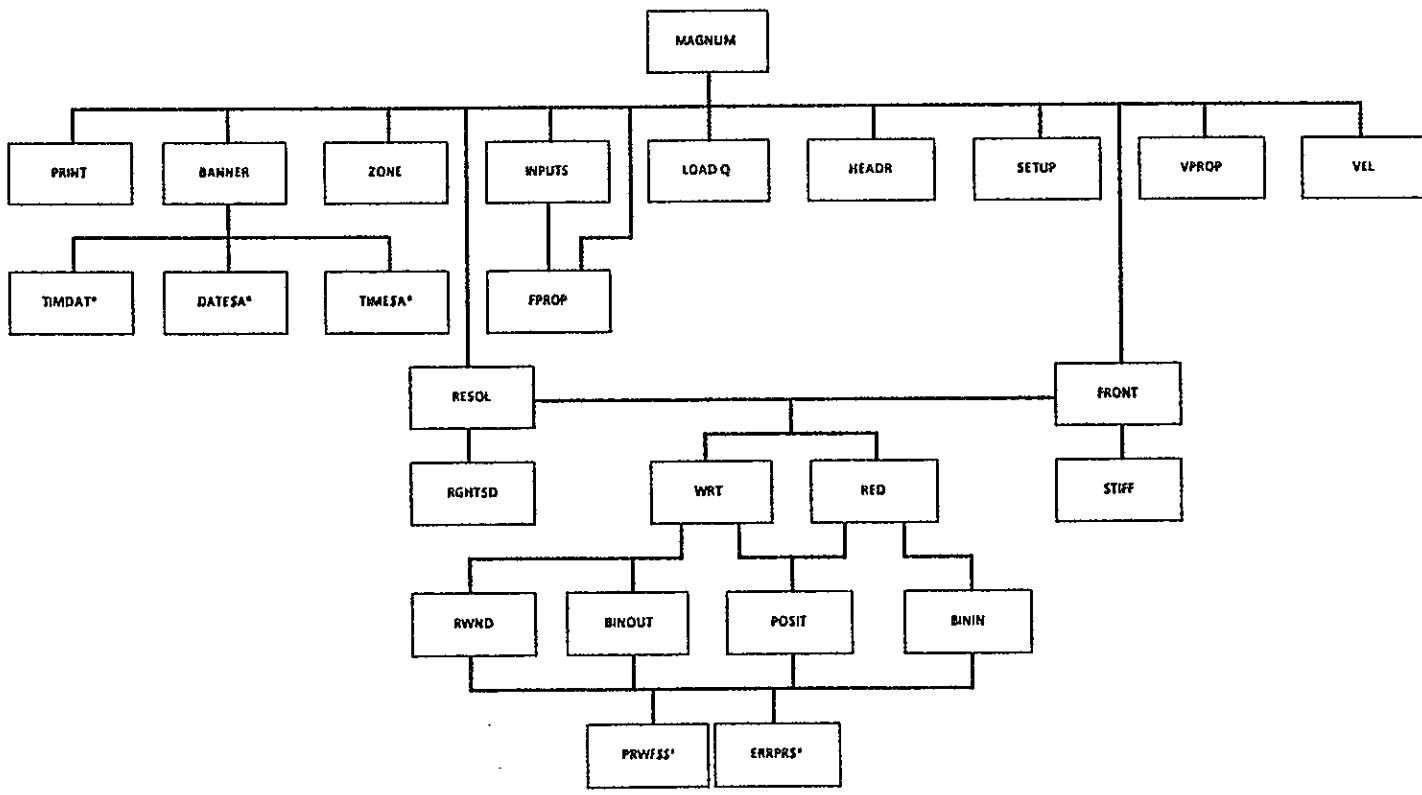


FIGURE A-1. Control Flow for MAGNUM-2D.

2 2 1 2 2 1 3 1 4 4 2



*PRIMOS (OPERATING SYSTEM SUBROUTINES)

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FIGURE A-2. Subroutine Hierarchy for MAGNUM 2-D.

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APPENDIX B

PREPROCESSORS

INTRODUCTION

A finite-element code such as MAGNUM-2D requires an extensive input data set, including a geometry, initial conditions, and boundary conditions. The creation of this data set can be automated to some extent by providing software "tools" to help the modeler develop and handle the requisite data. The tools used to create the data, known collectively as " preprocessors," deal mostly with the input geometry data. Geometries may be created, refined, modified, optimized, verified, and plotted. Two other preprocessors exist for creating initial and boundary condition data.

This appendix lists the preprocessors available for use with MAGNUM-2D and gives a brief description of each. A brief discussion is provided of the steps that must be followed to use the preprocessors to generate a data set describing a model to be used for a simulation.

Note that this section is not intended to be an instruction manual for any of the preprocessors described herein. At present, the preprocessors are self-help interactive FORTRAN programs.

MAGNUM-2D PREPROCESSORS

The FEMESH code is used to generate arbitrarily shaped, finite-element geometries. The input for FEMESH is a coarse finite-element geometry of quadrilateral elements followed by some refinement specifications telling FEMESH how the coarse mesh is to be subdivided. This input must be in literal ASCII form. The input format for the coarse geometry is exactly like that required for the MAGNUM-2D geometry. This allows the user to generate the coarse mesh "by hand" using a standard text editor program. The user may also generate the coarse mesh using GEN and later add the refinement data by hand using an editor. The FEMESH code will generate triangular, as well as quadrilateral elements, but the input is restricted to quadrilaterals.

The GEN code is a simple processor for generating regular, rectangular finite-element geometries of quadrilateral or line elements. No prior preparation of input data is required. The program prompts the user for all required input. The output geometry may be chosen as a set of quadrilaterals or a network of line elements. The lower left-hand corner of the rectangular area generated may start at (0.0, 0.0), or at whatever coordinates the user requests. All the elements will have a common, user-specified material type. The data generated by GEN is written to a formatted file and may be suitably modified for use by the FEMESH code by adding the refinement data required (see FEMESH).

The MERGE code is a processor that combines two model geometries into a single geometry. This allows the creation of large, finite-element geometries in smaller parts. The two geometries to be combined must be compatible along the sides that will become common. No overlap in the geometries being combined is allowed except in the case of line elements where the line element nodes will be merged if they coincide with the two-dimensional element nodes. One of the geometries being merged may have an offset defined for the node locations during the merge. This often simplifies generation of the subgeometries.

The MESHER code reorders the elements and/or nodes of a finite-element geometry. Reordering of element numbers is performed to minimize the bandwidth for MAGNUM-2D or CHAIN during the solution phase of the programs. The technique used is not a true optimization. Instead, MESHER requires an input starting list of nodes from which a near-optimum order is generated. Several different starting lists may be compared in one MESHER run, and the best of these will be automatically retained. The starting list of nodes is best chosen as the nodes along the shortest side of the mesh. A feature of MESHER is the ability to list all the boundary nodes and to indicate the corner nodes, allowing the user to try various sides and to make comparisons.

The MOD code allows the user to make simple modifications to a geometry including node position, geometry scaling, rotating, mirroring, or translating; to change the slope, angle, material type, or connectivity; to recalculate the midside node positions; or to create new elements. This program will allow changes to be made to a binary file where an editor would be ineffectual.

The PLT code is used for plotting two-dimensional finite-element geometries. All three element types (quadrilaterals, triangles, and lines) are recognized. The plots produced are the mesh alone; the mesh with node, element, or material types numbered; single elements; and subregions of the entire mesh with all the above options. (Note: This program makes use of the DISSPLA graphics system by ISSCO. This library of FORTRAN graphics routines is necessary to run PLT on any computer system.)

The PURGE code is used to verify a geometry. Checks are made for some of the more common errors. These include errors in element connectivity specification, midside node placement, unused nodes and elements, duplicate nodes, node rotation, free elements, ill-defined elements, aspect ratios that are potentially unacceptable, elements that overlap or are distorted, and correctness of the ordering array. Obvious errors, such as unused nodes and elements, are corrected while more subtle errors are noted for the user to correct.

The REFINE code allows single elements to be divided into two smaller elements or two smaller elements to be combined into one larger element.

The TRGEN code will generate a finite-element transition geometry using triangular elements to go from a region of smaller elements to a region of larger elements.

The BCGEN code is used to generate a boundary condition data file for input to MAGNUM-2D or CHAIN. A geometry is read from a geometry file, and a search is made for all boundary nodes. These nodes are then listed in counterclockwise order, and two user-supplied subroutines, BCHEAD and BCTEMP, are called to generate the boundary conditions for head and temperature, respectively.

The ICGEN code is used to generate an initial condition data file for input to MAGNUM-2D or CHAIN. A geometry is read from a geometry file, and the initial conditions are calculated based on position (or other appropriate variable) by a user-supplied function.

The ICMOD code is more of a utility than a preprocessor. It allows the user to convert an initial condition file to a file that looks like a binary results file. This file may be gridded and contoured for inspection. Alternately, a binary results file may be converted for use as a formatted initial condition file.

DATA GENERATION WALK THROUGH

The first step in the generation of any finite-element representation is the determination of the exact geometric definition of the physical system. This should include dimensions and locations of all features associated with the region being modeled, such as voids, varying material types, heat and fluid sources, etc. Once this data is collected, the modeler must determine the optimum form of the model to ensure accurate mathematical representation of the region and, therefore, accurate results. If the area of highest gradient can be identified beforehand, the modeling effort is often simplified and the model size is limited since this allows the element density to be restricted to those high-gradient regions.

A typical method for the creation of the model is for the modeler to start with a sketch of the region to be modeled. Any identifiable subregions are then indicated (i.e., subregions composed of a single material, voids, etc.), and a plan is determined, such as modeling these subregions and merging them into a whole model. This technique will be assumed in the following discussion.

A data flow diagram for the preprocessors and files discussed in this section is shown in Figure B-1. It is recommended that the reader follow this diagram while reading the remainder of this appendix.

Often the first program to be used, and perhaps the only one needed depending on the complexity of the model, is GEN. If it is convenient to produce the entire model or complete subregions with GEN, the task is simplified; however, GEN may also be used to generate a preliminary coarse mesh to which the refinement data is added using an editor, and this file is then run through FEMESH to refine and enhance the mesh.

Note that in creating the mesh for subregions, care should be exercised to ensure that the boundary nodes are located at common geometric points so that merging the meshes is possible. If the points do not coincide or at least vary with a constant x- or y-dimension offset, it will be necessary to modify a potentially large number of coordinates before merging is feasible.

If a transition zone is necessary between regions of varying element densities (i.e., between regions of suspected high and low gradients), then TRGEN may be used to produce the zone as a separate region.

The various "pieces" of the model may be combined or merged using MERGE. This program will take any two geometry files and attempt to merge them at their common node points; thus, the user may have to use this program several times depending on the number of subregions being combined. The MERGE code (like MESHER, MOD, and REFINE) has the ability to write the new geometry back into an old file or onto a new file, thus preserving the subregion data files for future use. A precaution is to maintain all the component geometries until the model generation, or some phase of it, has been verified to be correct. This allows the user to redo a portion of the geometry from the last correct phase in case a mistake is made.

At any point in the model generation procedure, the program PLT may be used to view the model. It is helpful to have hard copies of the element and node number plots at hand when merging geometries.

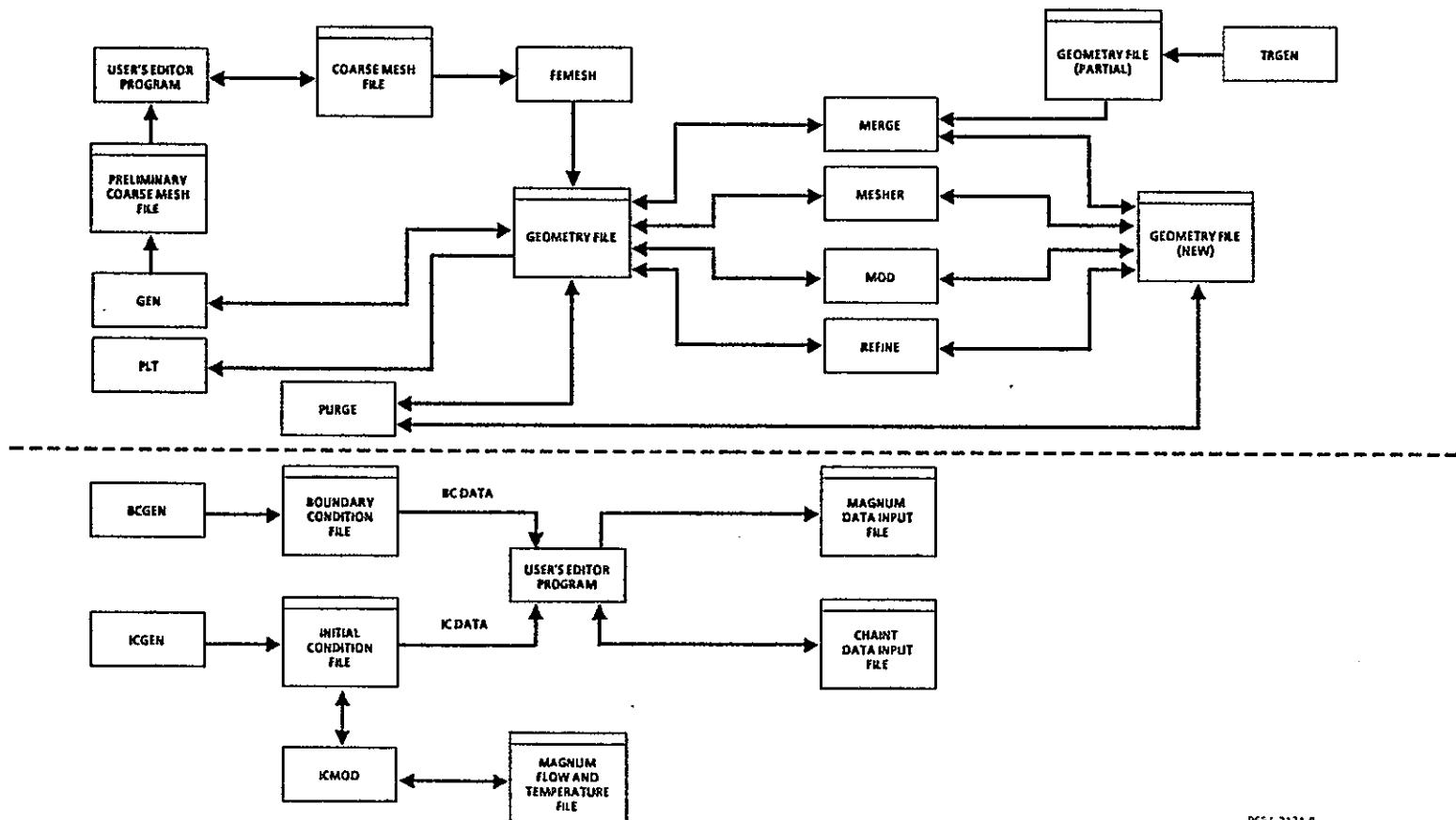
Often the automatically generated finite-element geometry is not sufficiently accurate or the region is too intricate to attempt defining adequate constraints for automatic generation. In these cases it is up to the modeler to amend and modify the geometry with a text editor to produce the desired results. The MOD program will allow the user to change node locations or connectivity. This is convenient when the material boundaries require specific location of elements or midside nodes do not fall where they should when generated automatically. In addition, MOD will allow the user to mirror or translate geometries so the modeler may use any symmetry in the model. The REFINE program is useful in "fine tuning" a geometry because it will allow the user to produce a fine mesh in just a few elements without defining a subregion. Both MOD and REFINE provide flexibility in "refitting" a model, that is, modifying it after it is complete for sensitivity analyses or because of features uncovered by the initial analysis.

After the model parts have been assembled and the actual node locations have been fine tuned, it is wise to run PURGE on the geometry. This ensures that many of the innocuous errors that propagate from the creation process are removed. These errors may not be large in themselves, but they may create great variations in the final simulation results if they occur in a critical location. It is probably a good idea to make at least one PLT run on the final geometry file for a final visual check. A hard copy of the node number, material type, and element number plots is essential in order to analyze the results of a simulation in detail.

When the geometry file has been created, it may be in one of two forms: either binary or formatted (ASCII, BCD, etc.). Either of these is readable from MAGNUM-2D or CHAIN. It may be utilized by reading the file directly from mass storage (in coded or binary form) or, in the case of a coded file, it may be edited into an input file that contains all the other data necessary for the simulation (boundary conditions, material properties, and other data as contained in card types A through R).

Using an editor program, the remainder of the data required for simulation as described in card types A through R is usually entered into a mass storage file, the MAGNUM-2D data input file. Card types G and H, which describe the geometry, may be entered from the coded form of the geometry file or may be omitted and read from a binary or formatted mass storage file at execution time by specifying the logical unit number on card type C. The initial and boundary conditions, however, must be included in the MAGNUM-2D data input file. If they are few or straightforward, they may be entered directly by using the editor. If they are numerous, the two programs ICGEN and BCGEN may be used to produce files of initial and boundary conditions, respectively, which are edited into the data input file.

A data flow diagram for the MAGNUM-2D and CHAIN environment and the data files involved is shown in Figure B-2. Note that for a nonrestart job, only two input files are needed: the MAGNUM-2D data input file and the geometry file. (Only one input file is needed if the geometry input is included directly on the MAGNUM-2D data input file.)



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FIGURE B-1. Preprocessor Data Flow.

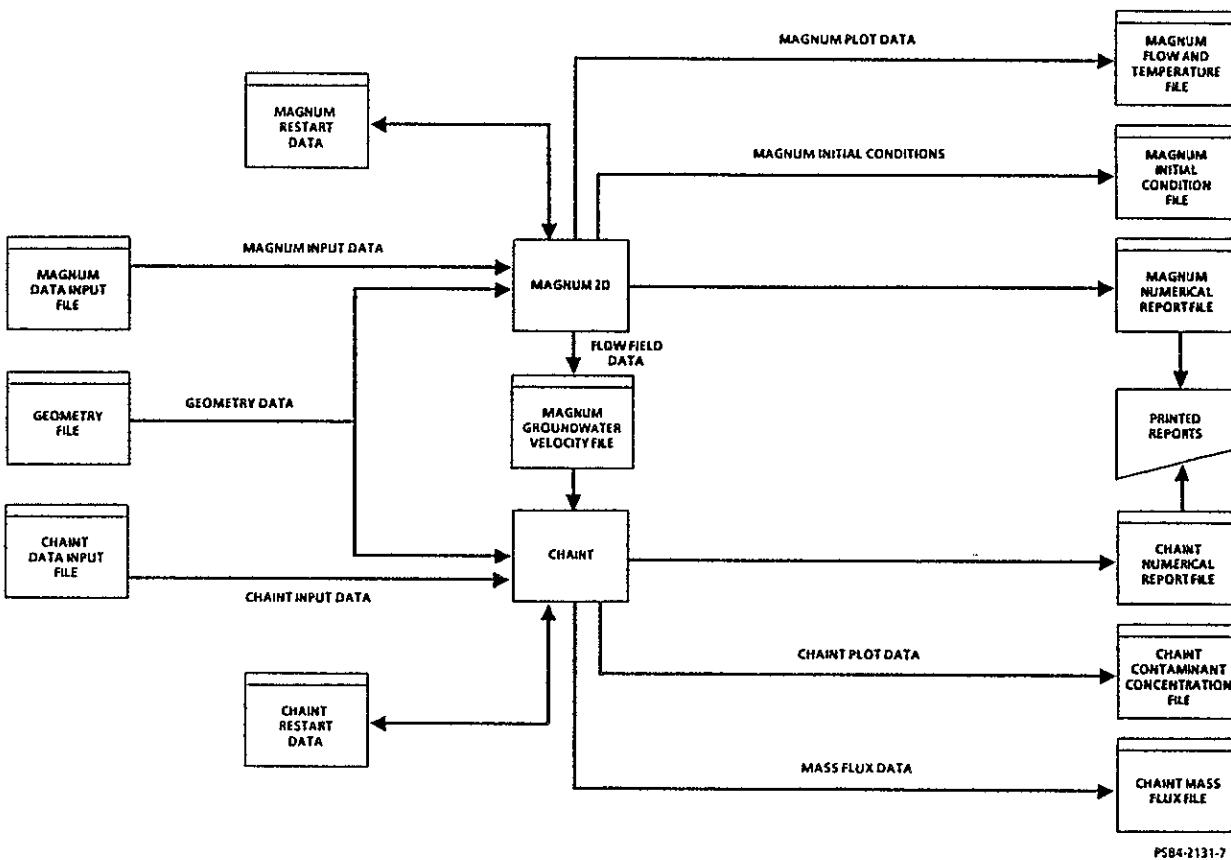


FIGURE B-2. MAGNUM/CHAIANT Data Flow.

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APPENDIX C

POSTPROCESSORS

INTRODUCTION

A finite-element code, such as MAGNUM-2D or CHAIN, creates a large amount of output data that are often difficult to interpret in their raw form. Postprocessors provide a means of graphically displaying output data in a variety of modes. These may be two-dimensional contour plots of the results, cross-sectional plots of the data versus position, or time history plots for the data at a given location. In addition, pathlines, streamlines, velocity vectors, and mass flux data may be plotted.

This appendix lists the most commonly used postprocessors for MAGNUM-2D and gives a brief description of each.

Note that this section is not intended to be an instruction manual for any of the postprocessors described herein. Each of the graphics postprocessors is a self-help interactive FORTRAN program.

All of the graphics postprocessors utilize subroutines from the ISSCO DISSPLA graphics system. The DISSPLA graphics system is mandatory for utilization of these programs.

MAGNUM-2D POSTPROCESSORS

A data flow diagram for the postprocessors and files discussed in this section is shown in Figure C-1. Note from Figure B-2 that there are five files output from MAGNUM-2D but that only three are shown in Figure C-1. These are the only files that are used in postprocessing. They are the geometry file, the MAGNUM-2D groundwater velocity file, and the MAGNUM-2D flow and temperature file.

First and probably foremost is the program CHAIN. While not strictly a postprocessor, it may utilize the MAGNUM-2D groundwater velocity file as input to define the flow field to be used in solving the mass transport equations. No manipulation or modification of the file is required before its use by CHAIN.

The GRIDDER postprocessor interpolates nonregularly spaced nodal data onto a regular rectangular grid to allow contouring. The GRIDDER postprocessor ignores data associated with line elements. The sister program LEGRID will grid line elements only. They accept the MAGNUM-2D flow and temperature file as input and place the output data in an output file that may be used by CONTOUR, HISTORY, AND PARAM.

The CONTOUR postprocessor is used to draw contour line plots from data given as a function of two space variables. The MAGNUM-2D flow and temperature data must be interpolated onto a regular, rectangular grid using

GRIDDER prior to using CONTOUR. This program is totally interactive, and the user is prompted to enter commands to set the desired plotting options, such as contour levels, background, and time plane of interest.

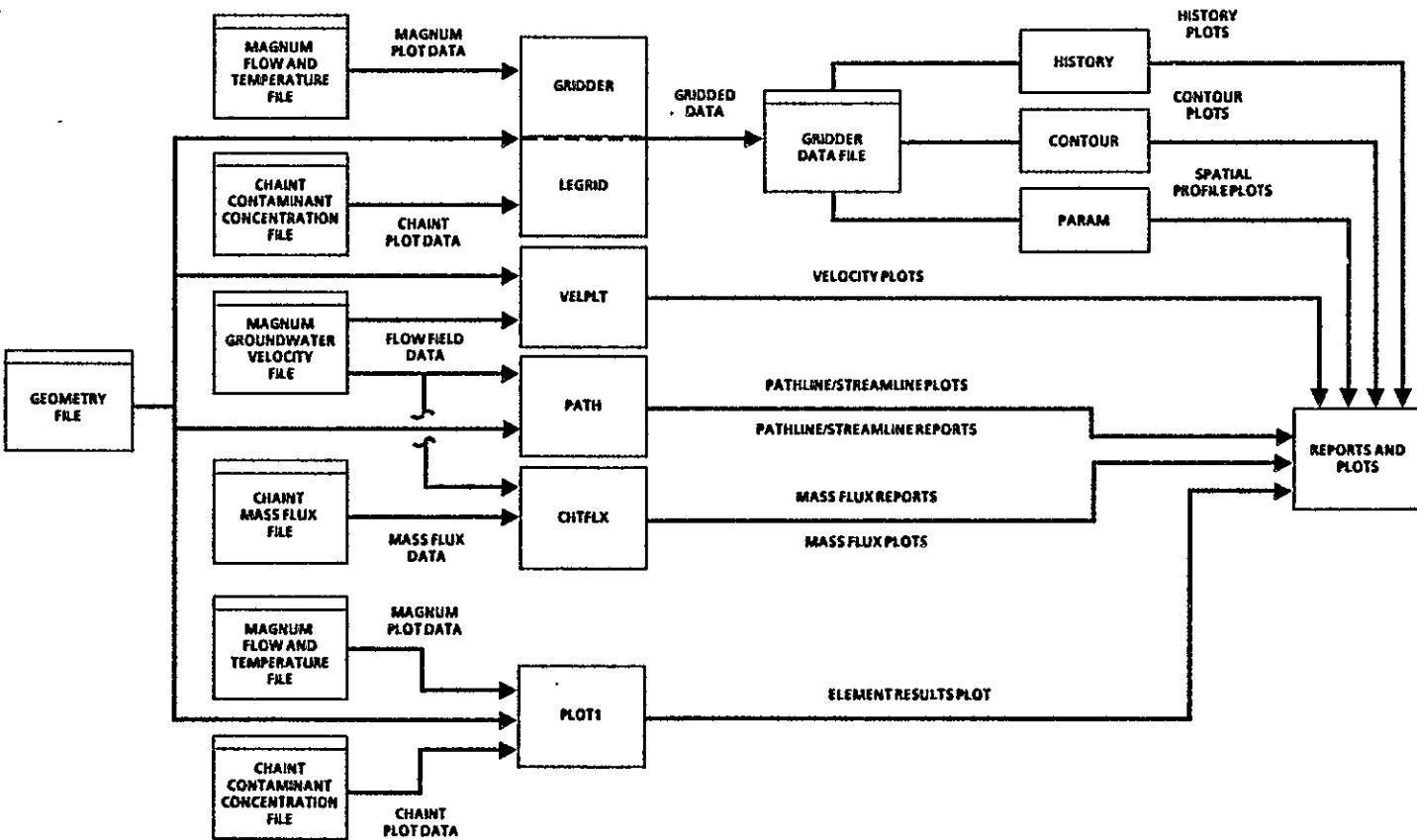
The HISTORY postprocessor is used to plot results as a function of time. The data histories corresponding to chosen locations in a finite-element geometry are plotted. The histories of several points may be plotted on a single graph. The MAGNUM-2D flow and temperature data must be interpolated onto a regular, rectangular grid using GRIDDER prior to using HISTORY.

The PARAM postprocessor is used to plot data cross sections. Data are plotted as a function of x or y, with either y, x, or t being varied as a parameter. Several curves may be plotted on a single graph. The MAGNUM-2D flow and temperature data must be interpolated onto a regular, rectangular grid using GRIDDER prior to using PARAM.

The VELPLT postprocessor is used to plot velocity vectors from the groundwater velocity file. The vectors can be scaled or plotted at uniform lengths and may be generated with a background of the geometry boundaries. The vectors may also be drawn in their true directions or relative to the geometry background. The VELPLT postprocessor also requires the geometry file as input. The user is prompted for both file names and all directives.

The PATH postprocessor generates plots of flow paths through a two-dimensional finite-element geometry. Both pathlines (time varying flow fields) and streamlines (flow at a single time plane) can be created. The path length and travertime for each pathline or streamline are computed and printed to the terminal after each plot is complete. The user is prompted both for file names and for all directives to select subplots, time markers, background, and pathline and streamline starting points. Input data for PATH include the groundwater velocity file and the corresponding geometry file.

The PLOT1 postprocessor is used to plot the flow and temperature file on an element by element basis. A three-dimensional surface of the data is plotted along with a two-dimensional sketch of the element with written node values at each node. This program is useful as a diagnostic tool in the analysis of data anomalies. An error of insufficient geometry resolution often can be determined by examining the surface plot for data corresponding to a single element. The PLOT1 postprocessor also requires the geometry file as input.



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FIGURE C-1. Postprocessor Data Flow.

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APPENDIX D

EXAMPLE CASES

Reproduced listings of the PRIMOS commands, input, and printed output for two example problems are contained in this appendix.

The first example is a one-dimensional coupled flow and heat transfer problem with a thermal load. A single column of elements with a linear head gradient is defined from bottom to top with a single heat source specified in the element at the bottom end (element 1). The resulting head and temperature cross sections at selected times are shown in graphic form in Figures D-1 and D-2 as produced from the postprocessor PARAM. The geometry in this example is specified in the data input file, Listing D-1. The PRIMOS commands used to run this example are shown in Listing D-2. The resulting output is shown in Listing D-3.

The second example is a two-dimensional flow problem with heat transfer and a thermal load. The model is shown in Figures D-3 and D-4. Note that Figure D-3 is only the mesh; the node numbering option in the PLT program was not used. Also, Figure D-4 is a close-up of a specific detail on the model and includes element numbers. The model is typical of the type that might be used for a repository simulation (although much simplified) showing perhaps a bored repository with provisions for modeling the host rock, the grout or backfill, and the waste container. The semicircular area containing elements 70, 71, 84, etc., are heat source elements, and both the top and bottom boundaries are specified to be at 50 °C. The top boundary is also specified to have a 1.0-m hydraulic head while the bottom is 1.2 m. The simulation is set to run for 10 yr. Figures D-5 through D-10 show the head and temperature distributions at selected times ranging from 0-10 yr. All these plots were generated using CONTOUR. Figures D-11 and D-12 show the head and temperature histories of five specific points in the model, all of which lie along the horizontal plane of symmetry. The data input file is shown in Listing D-4. Note that the geometry in this case has been defined on an external mass storage file and has been specified as LUN 11. The PRIMOS commands used to run this example are shown in Listing D-5. Note also the specification of Unit 11 to correspond to the filename VEL. The resulting report file is shown in Listing D-6.

2 2 1 2 4 1 3 1 1 5 7

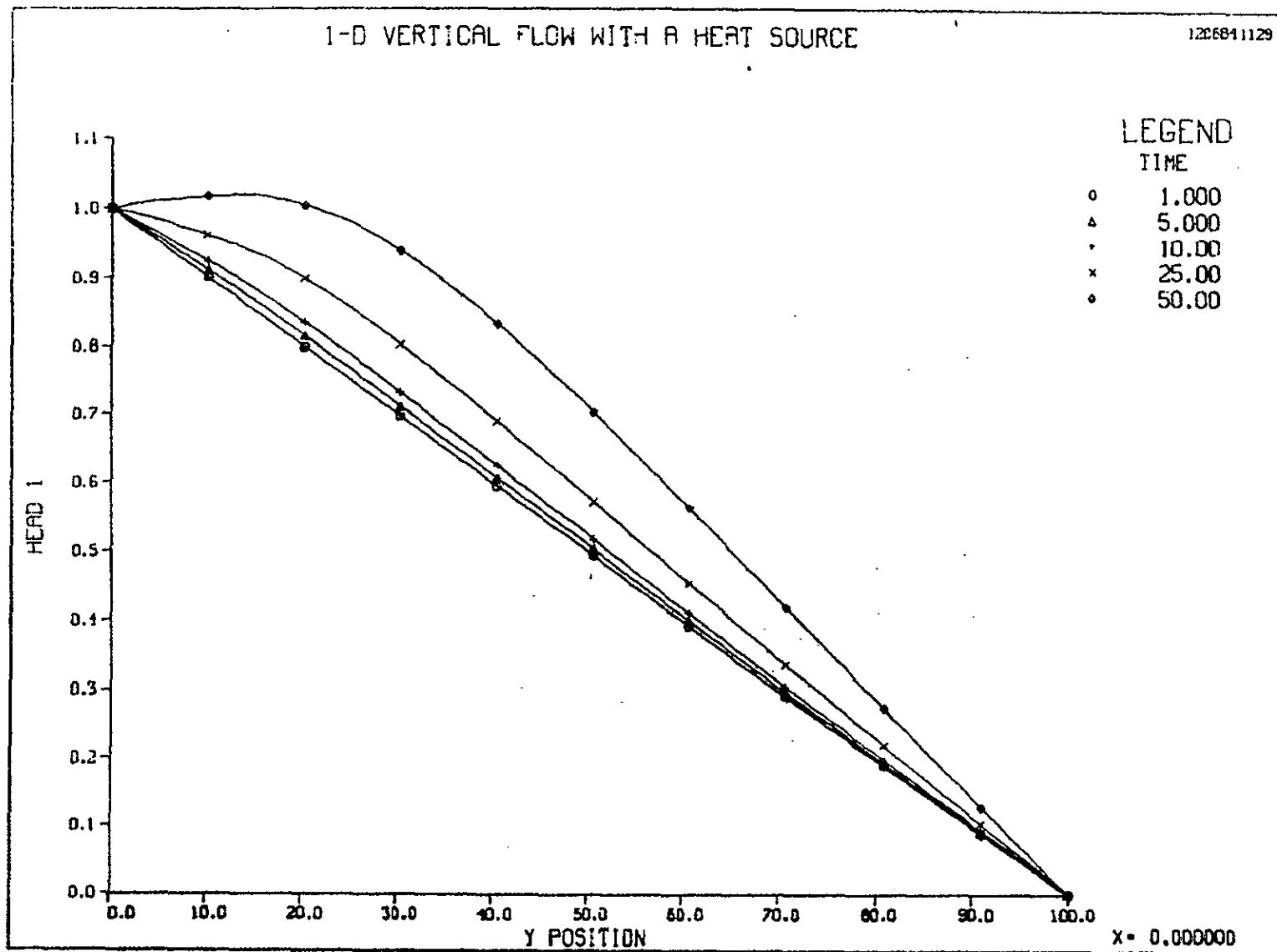
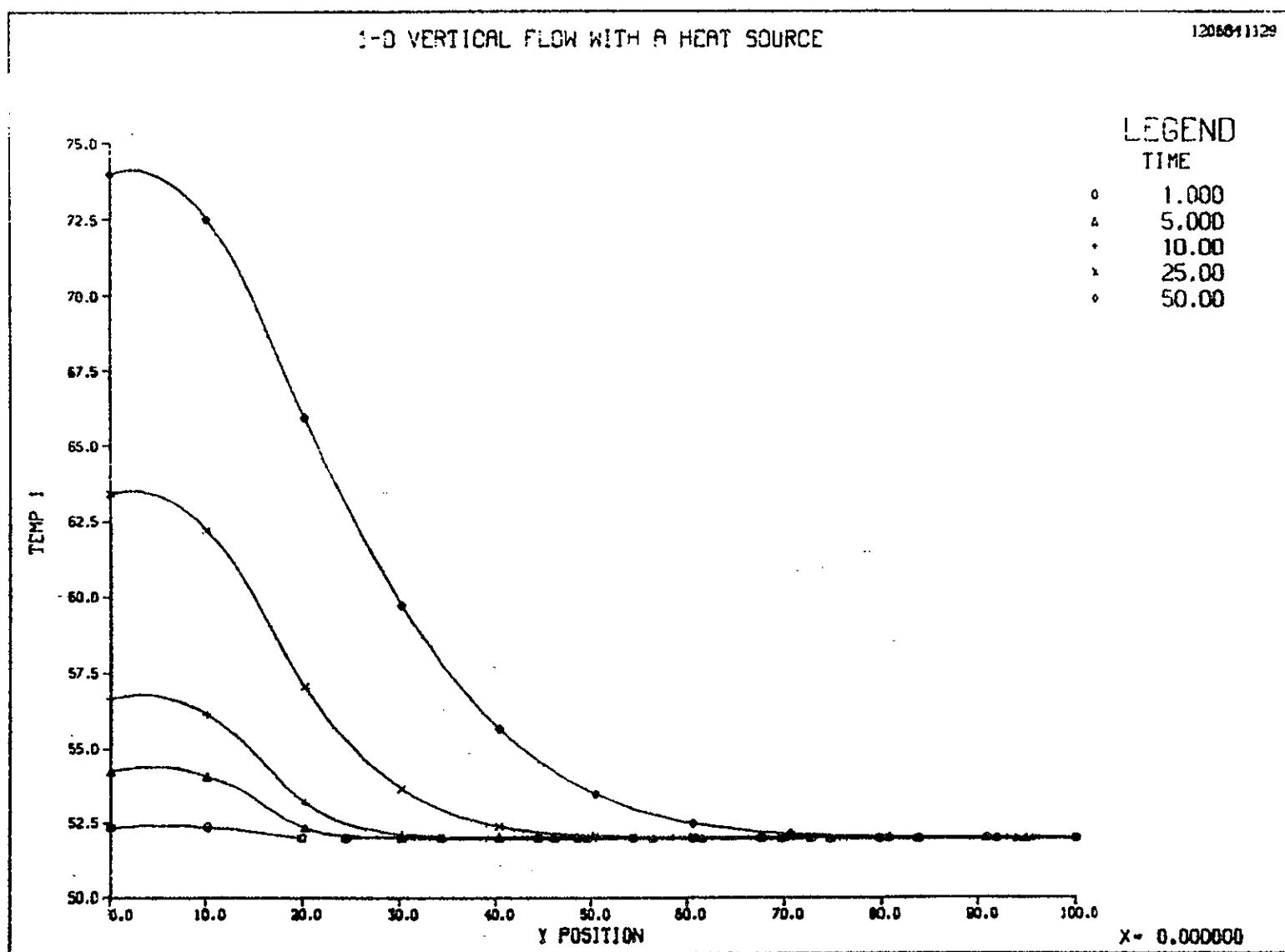


FIGURE D-1. Hydraulic Head Profiles for Test Case One.

3 2 1 2 4 1 3 1 4 5 8



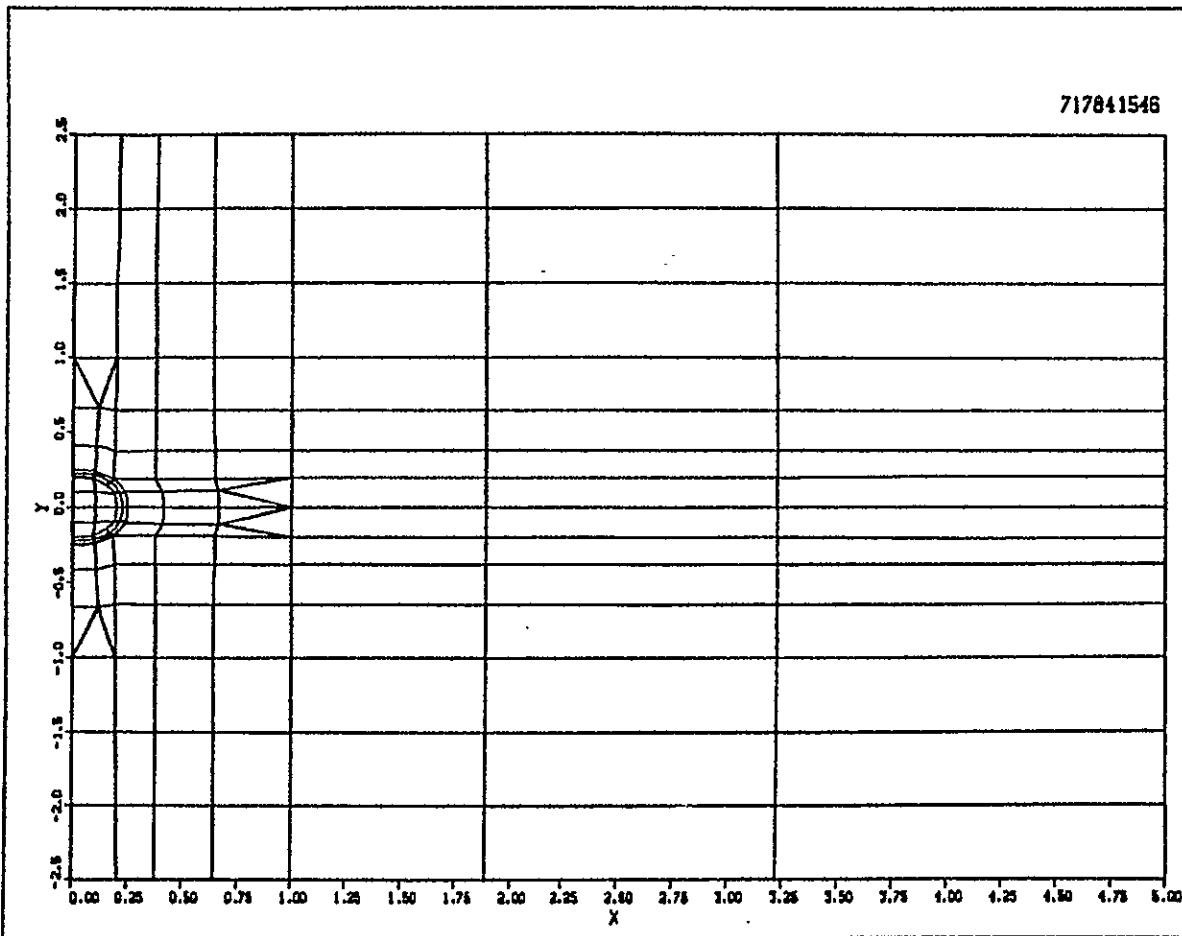
D-3

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FIGURE D-2. Temperature Profiles for Test Case One.

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D-4

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FIGURE D-3. Finite-Element Grid for Test Case Two.

2 3 1 2 4 1 3 1 4 5 0

RHO-BW-CR-143 P

D-5

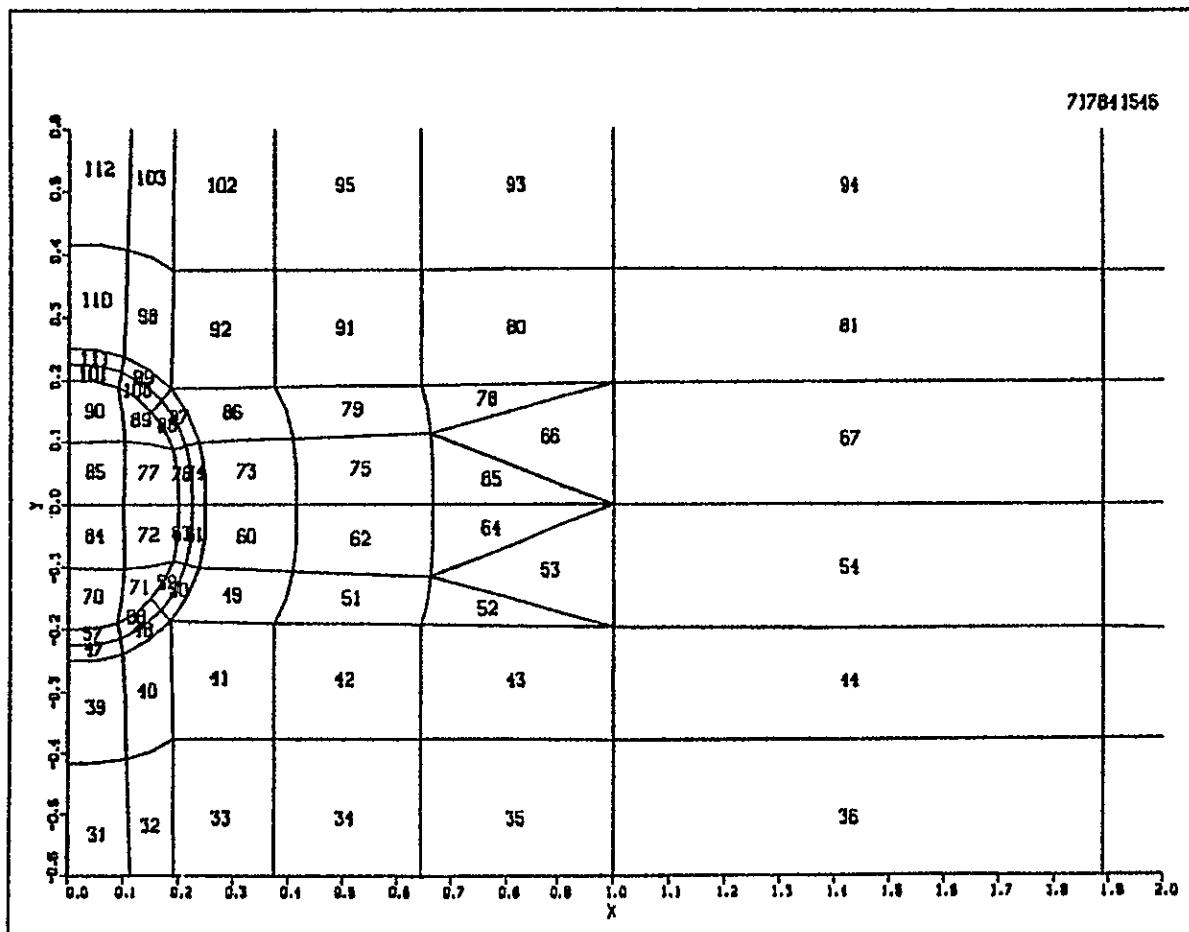


FIGURE D-4. Closeup View of Heat Source Gridding with Element Numbers for Test Case Two.

2 2 1 2 4 1 3 1 4 6 1

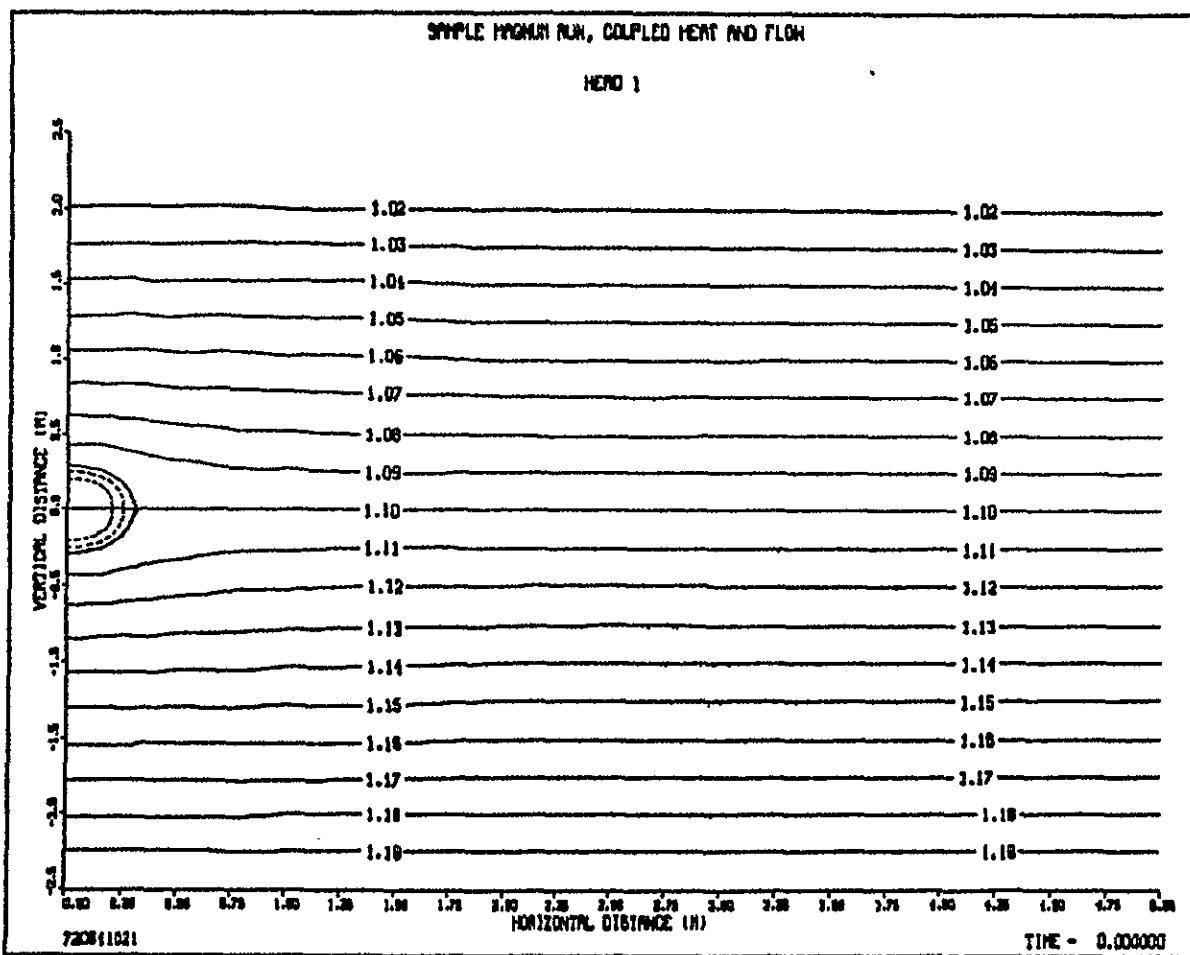


FIGURE D-5. Initial Hydraulic Head Contours for Test Case Two.

2 4.56 1977-78 1978-79 1979-80 1980-81 1981-82 1982-83 1983-84 1984-85 1985-86 1986-87 1987-88 1988-89 1989-90 1990-91 1991-92 1992-93 1993-94 1994-95 1995-96 1996-97 1997-98 1998-99 1999-2000

RHO-BW-CR-143 P

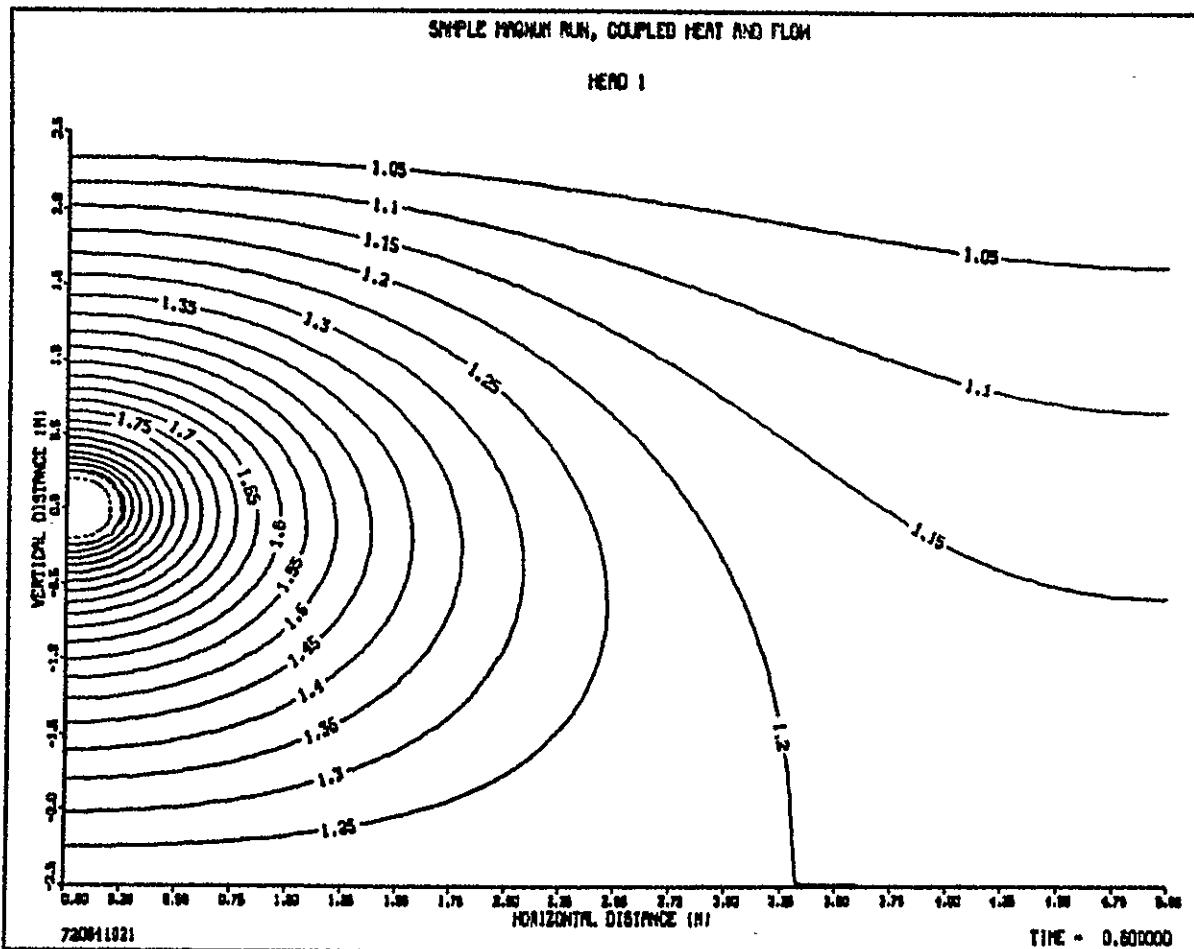


FIGURE D-6. Hydraulic Head Contours at 0.6 Year for Test Case Two.

2 1 2 4 1 3 1 1 6 3

RHO-BW-CR-143 P

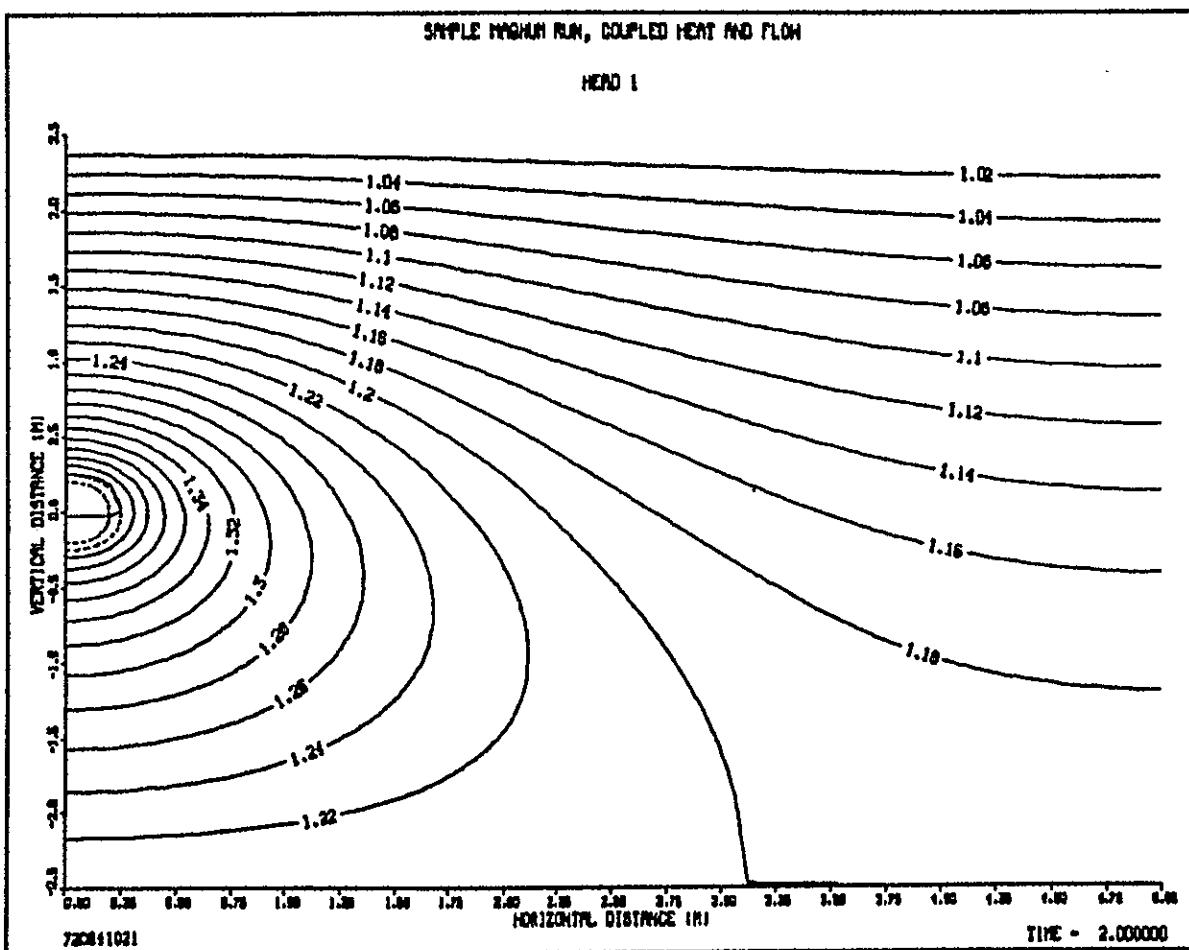


FIGURE D-7. Hydraulic Head Contours at Two Years for Test Case Two.

3 2 1 2 4 1 3 1 4 5 4

RHO-BW-CR-143 P

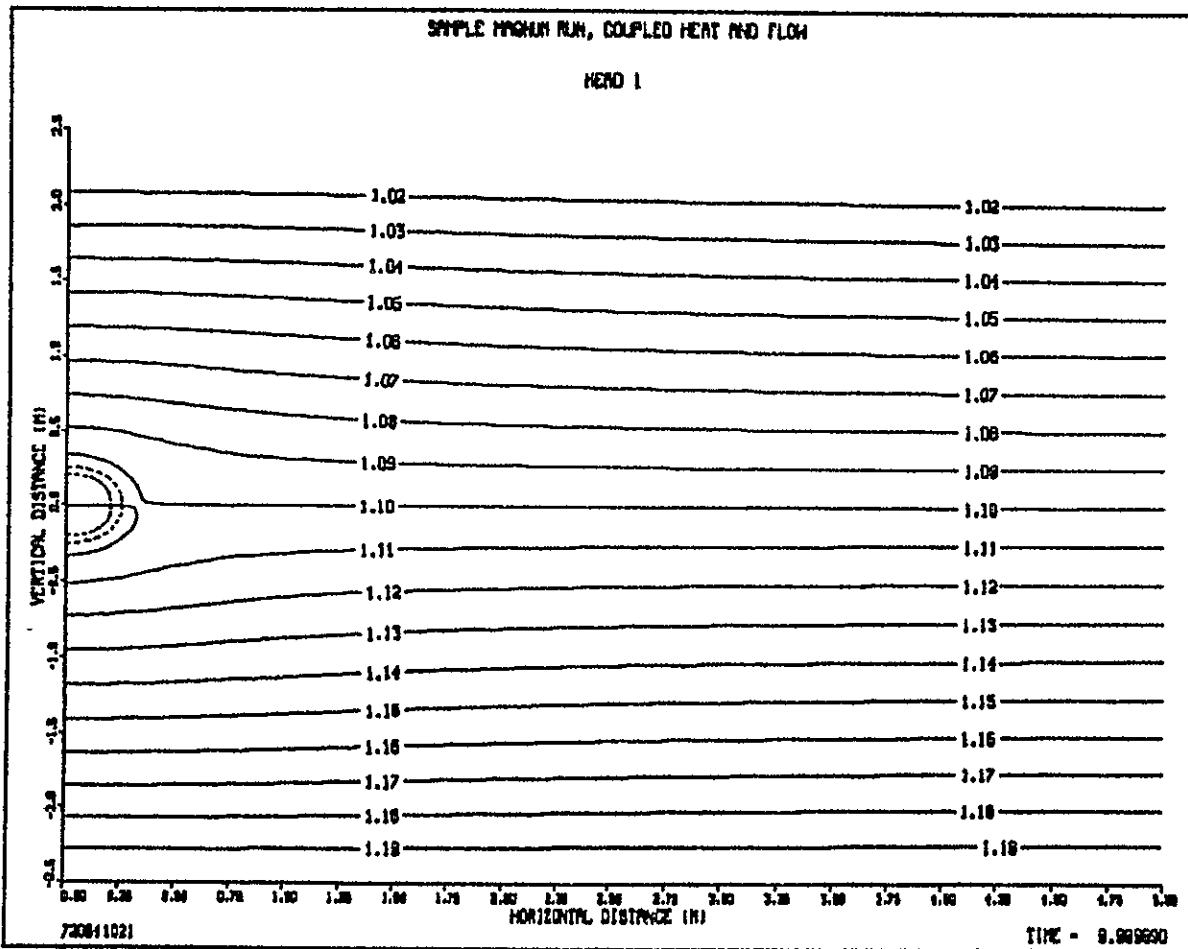


FIGURE D-8. Hydraulic Head Contours at 10 Years for Test Case Two.

2 2 1 2 4 1 3 1 4 5 5

D-10

RHO-BM-CR-143 P

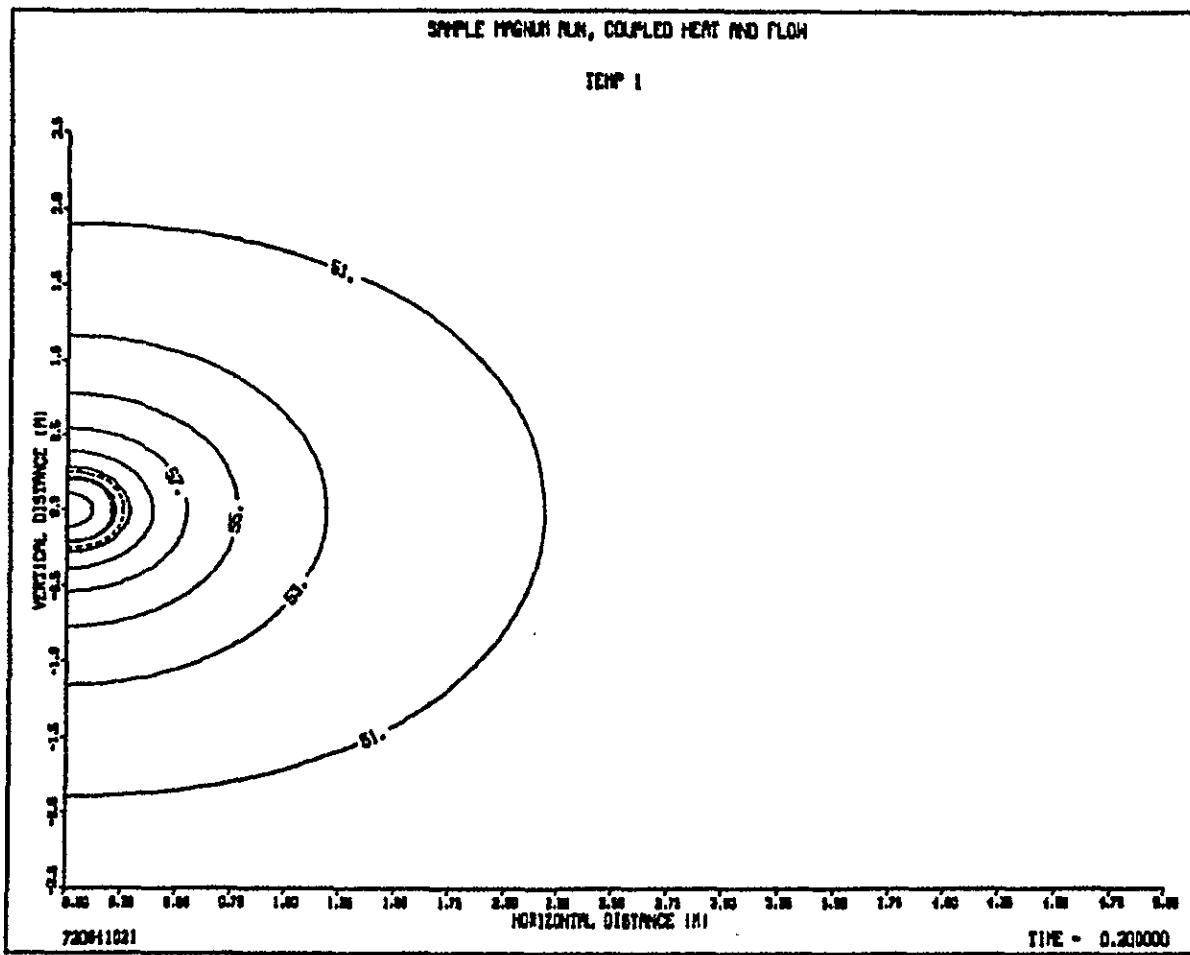


FIGURE D-9. Temperature Contours at 0.2 Year for Test Case Two.

1 2 3 4 5 6 7 8 9

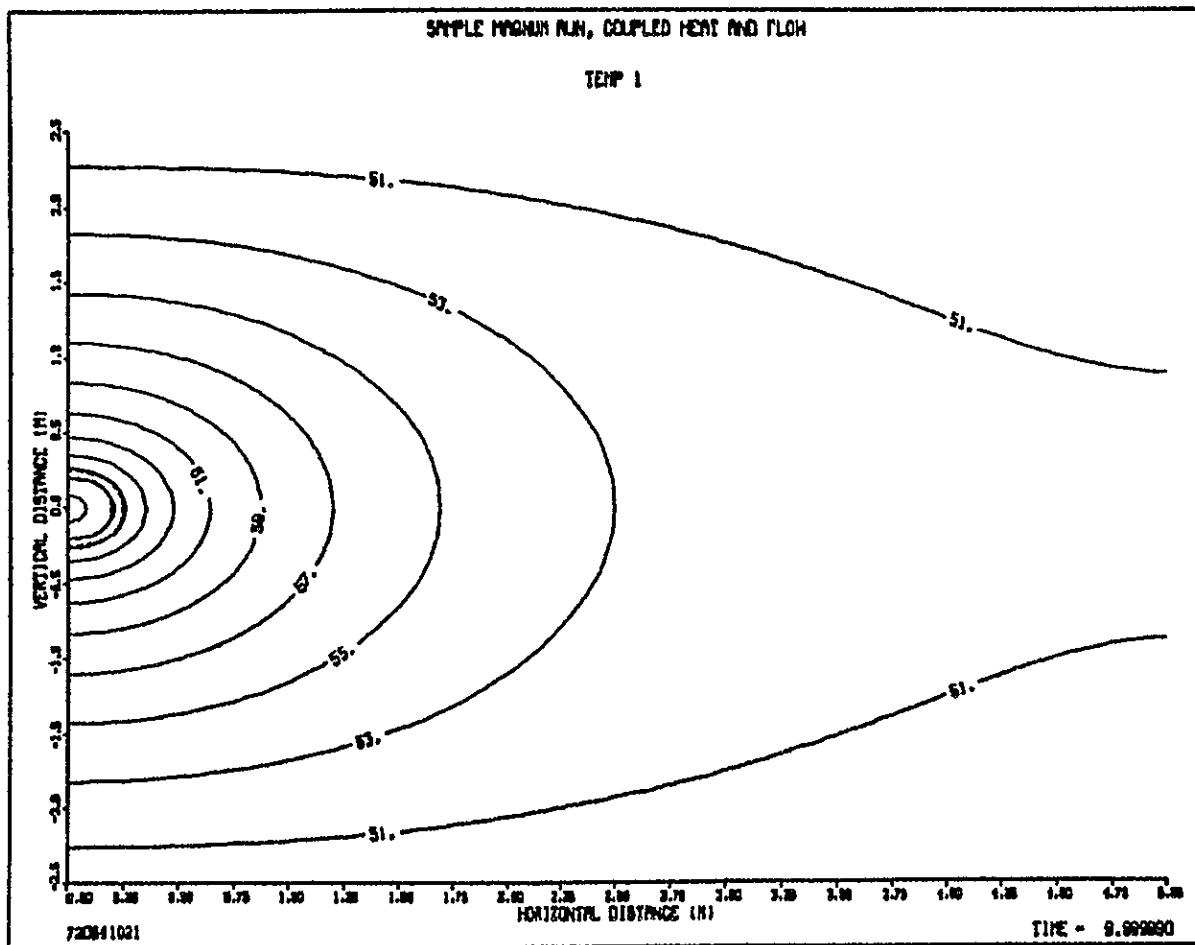


FIGURE D-10. Temperature Contours at 10 Years for Test Case Two.

2 2 1 2 4 1 3 1 3 6 7

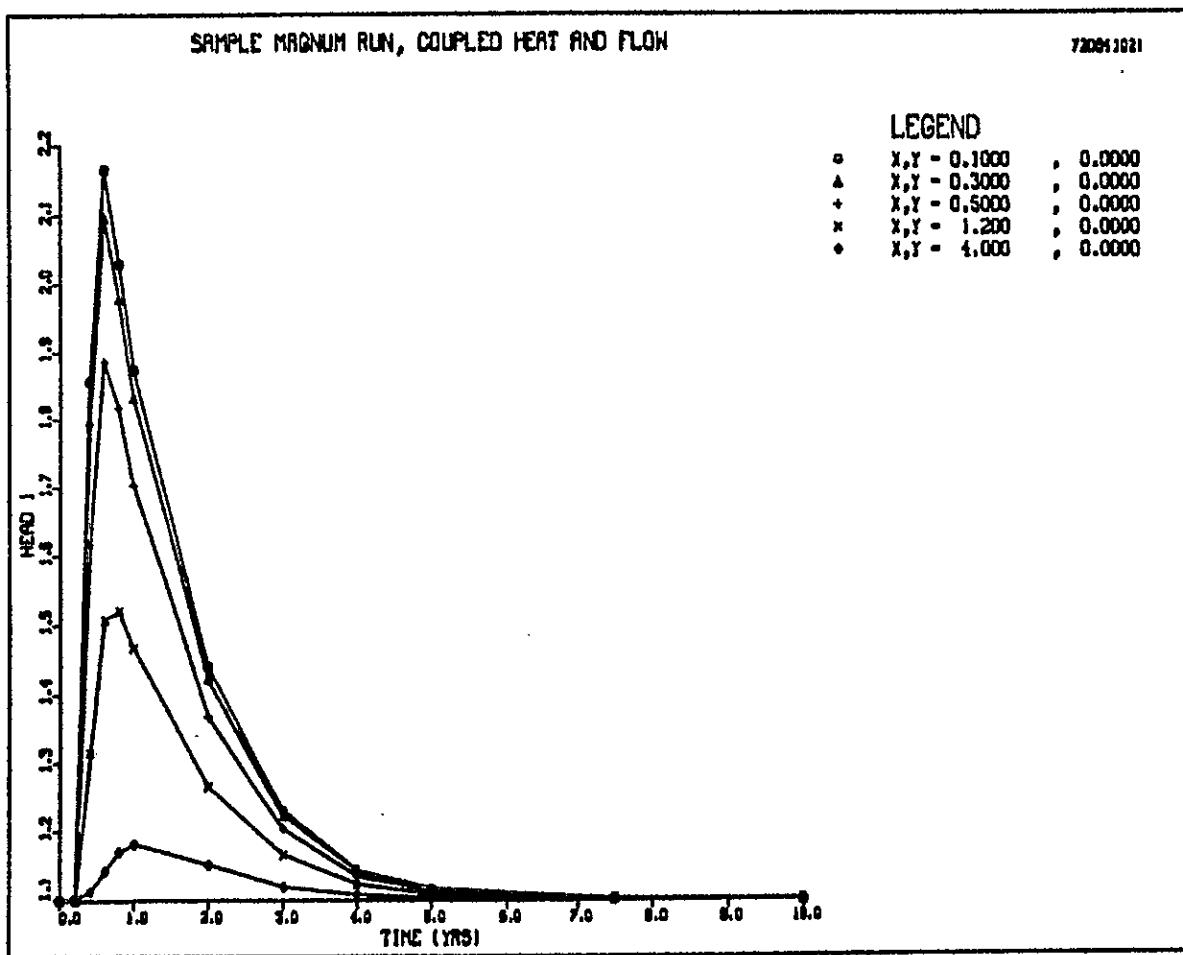


FIGURE D-11. Time History of Hydraulic Head at Selected Points for Test Case Two.

9 2 1 2 4 1 3 1 4 5 3

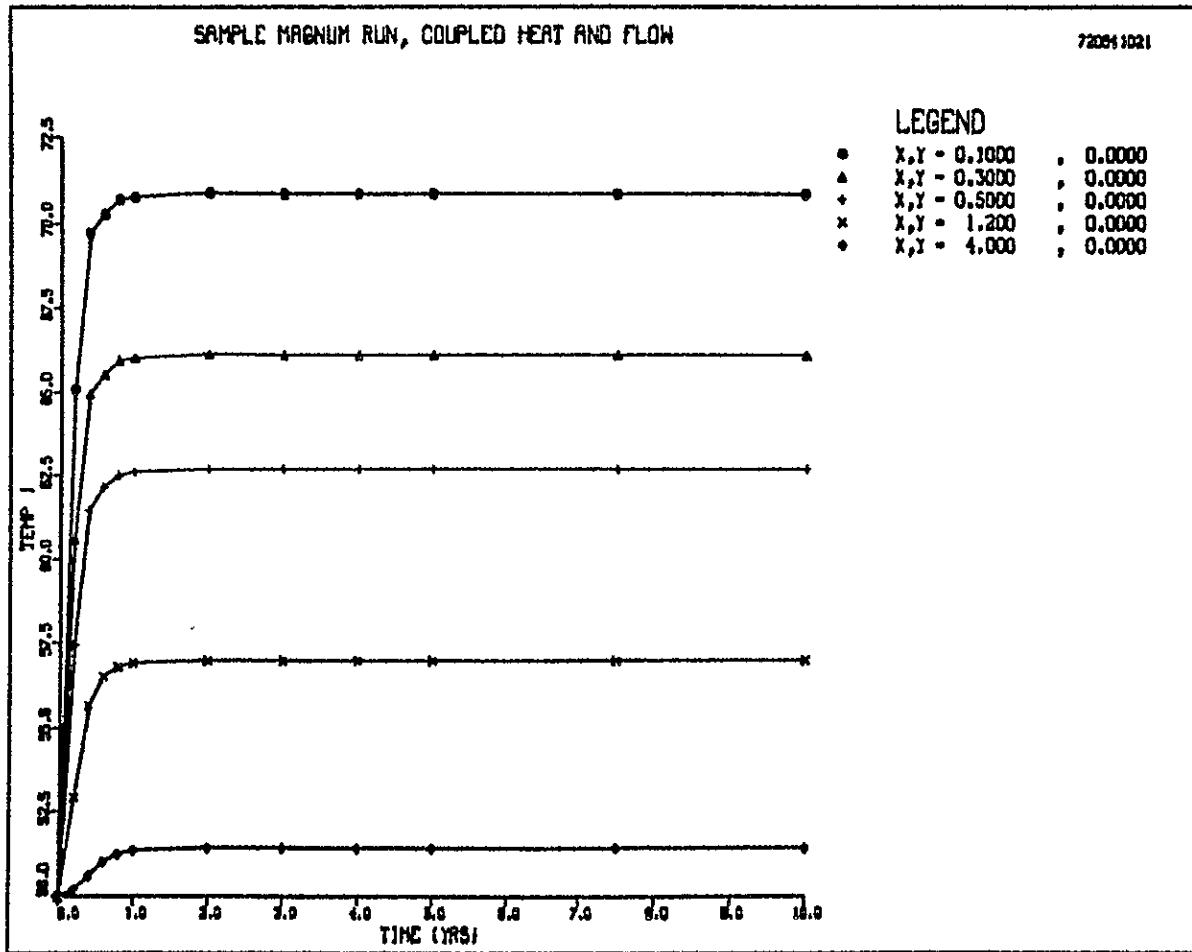


FIGURE D-12. Time History of Temperature at Selected Points for Test Case Two.

LISTING D-1. Input Data File for Test Case One. (Sheet 1 of 3)

ONE DIMENSION VERTICAL FLOW WITH HEAT GENERATION

ONE DIMENSION VERTICAL FLOW WITH HEAT GENERATION

0	1	1	53	10	1	1	1	1	1	0	0	/#CNTRL
0	8	0	0	11	12	0						/#FILE UNITS
0.				1.8	0.0		0.0		0.0		0.0	/#STRT TME
4	4			0.5								
3	3			1.0								
6	6			2.5								
6	6			5.0								
9999												
	1.0	1.0		0.0	0.0		0.0		0.0		0.0	/#SCALE
1	1	2	3	5	8	7	6	4	1	1	1	/#QEDM
2	6	7	8	10	13	12	11	9	1	2		
3	11	12	13	15	18	17	16	14	1	3		
4	16	17	18	20	23	22	21	19	1	4		
5	21	22	23	25	28	27	26	24	1	5		
6	26	27	28	30	33	32	31	29	1	6		
7	31	32	33	35	38	37	36	34	1	7		
8	36	37	38	40	43	42	41	39	1	8		
9	41	42	43	45	48	47	46	44	1	9		
10	46	47	48	50	53	52	51	49	1	10		
1	-5.000			0.000			0.00					
2	0.000			0.000			0.00					
3	5.000			0.000			0.00					
4	-5.000			7.500			0.00					
5	5.000			7.500			0.00					
6	-5.000			15.000			0.00					
7	0.000			15.000			0.00					
8	5.000			15.000			0.00					
9	-5.000			20.000			0.00					
10	5.000			20.000			0.00					
11	-5.000			25.000			0.00					
12	0.000			25.000			0.00					
13	5.000			25.000			0.00					
14	-5.000			27.500			0.00					
15	5.000			27.500			0.00					
16	-5.000			30.000			0.00					
17	0.000			30.000			0.00					
18	5.000			30.000			0.00					
19	-5.000			32.500			0.00					
20	5.000			32.500			0.00					
21	-5.000			35.000			0.00					
22	0.000			35.000			0.00					
23	5.000			35.000			0.00					
24	-5.000			37.500			0.00					
25	5.000			37.500			0.00					
26	-5.000			40.000			0.00					
27	0.000			40.000			0.00					
28	5.000			40.000			0.00					
29	-5.000			45.000			0.00					
30	5.000			45.000			0.00					
31	-5.000			50.000			0.00					
32	0.000			50.000			0.00					
33	5.000			50.000			0.00					

LISTING D-1. Input Data File for Test Case One. (Sheet 2 of 3)

ONE DIMENSION VERTICAL FLOW WITH HEAT GENERATION

2 2 1 2 4 1 3 1 4 7 0
34 -5.000 56.000 0.00
35 5.000 56.000 0.00
36 -5.000 62.000 0.00
37 5.000 62.000 0.00
38 -5.000 68.500 0.00
39 5.000 68.500 0.00
40 5.000 75.000 0.00
41 -5.000 75.000 0.00
42 5.000 75.000 0.00
43 -5.000 80.000 0.00
44 5.000 80.000 0.00
45 -5.000 85.000 0.00
46 5.000 85.000 0.00
47 -5.000 92.500 0.00
48 5.000 92.500 0.00
49 -5.000 100.000 0.00
50 5.000 100.000 0.00
51 -5.000 100.000 0.00
52 5.000 100.000 0.00
53 -5.000 100.000 0.00
54 5.000 100.000 0.00
55 -5.000 100.000 0.00
56 5.000 100.000 0.00
57 -5.000 100.000 0.00
58 5.000 100.000 0.00
59 -5.000 100.000 0.00
60 5.000 100.000 0.00
61 -5.000 100.000 0.00
62 5.000 100.000 0.00
63 -5.000 100.000 0.00
64 5.000 100.000 0.00
65 -5.000 100.000 0.00
66 5.000 100.000 0.00
67 -5.000 100.000 0.00
68 5.000 100.000 0.00
69 -5.000 100.000 0.00
70 5.000 100.000 0.00
71 -5.000 100.000 0.00
72 5.000 100.000 0.00
73 -5.000 100.000 0.00
74 5.000 100.000 0.00
75 -5.000 100.000 0.00
76 5.000 100.000 0.00
77 -5.000 100.000 0.00
78 5.000 100.000 0.00
79 -5.000 100.000 0.00
80 5.000 100.000 0.00
81 -5.000 100.000 0.00
82 5.000 100.000 0.00
83 -5.000 100.000 0.00
84 5.000 100.000 0.00
85 -5.000 100.000 0.00
86 5.000 100.000 0.00
87 -5.000 100.000 0.00
88 5.000 100.000 0.00
89 -5.000 100.000 0.00
90 5.000 100.000 0.00
91 -5.000 100.000 0.00
92 5.000 100.000 0.00
93 -5.000 100.000 0.00
94 5.000 100.000 0.00
95 -5.000 100.000 0.00
96 5.000 100.000 0.00
97 -5.000 100.000 0.00
98 5.000 100.000 0.00
99 -5.000 100.000 0.00
100 5.000 100.000 0.00
101 -5.000 100.000 0.00
102 5.000 100.000 0.00
103 -5.000 100.000 0.00
104 5.000 100.000 0.00
105 -5.000 100.000 0.00
106 5.000 100.000 0.00
107 -5.000 100.000 0.00
108 5.000 100.000 0.00
109 -5.000 100.000 0.00
110 5.000 100.000 0.00
111 -5.000 100.000 0.00
112 5.000 100.000 0.00
113 -5.000 100.000 0.00
114 5.000 100.000 0.00
115 -5.000 100.000 0.00
116 5.000 100.000 0.00
117 -5.000 100.000 0.00
118 5.000 100.000 0.00
119 -5.000 100.000 0.00
120 5.000 100.000 0.00
121 -5.000 100.000 0.00
122 5.000 100.000 0.00
123 -5.000 100.000 0.00
124 5.000 100.000 0.00
125 -5.000 100.000 0.00
126 5.000 100.000 0.00
127 -5.000 100.000 0.00
128 5.000 100.000 0.00
129 -5.000 100.000 0.00
130 5.000 100.000 0.00
131 -5.000 100.000 0.00
132 5.000 100.000 0.00
133 -5.000 100.000 0.00
/ *IC

LISTING D-1. Input Data File for Test Case One. (Sheet 3 of 3)

ONE DIMENSION VERTICAL FLOW WITH HEAT GENERATION

```

34      52.00  4.40E-01
35      52.00  4.40E-01
36      52.00  3.80E-01
37      52.00  3.80E-01
38      52.00  3.80E-01
39      52.00  3.15E-01
40      52.00  3.15E-01
41      52.00  2.50E-01
42      52.00  2.50E-01
43      52.00  2.50E-01
44      52.00  2.00E-01
45      52.00  2.00E-01
46      52.00  1.50E-01
47      52.00  1.50E-01
48      52.00  1.50E-01
49      52.00  7.50E-02
50      52.00  7.50E-02
51      52.00  0.00E+01
52      52.00  0.00E+01
53      52.00  0.00E+01
6          *B.C.
1        01      52.0      1.0
2        01      52.0      1.0
3        01      52.0      1.0
51        11      52.0      0.0
52        11      52.0      0.0
53        11      52.0      0.0
1        1000.0    0.200    0.200    1.0E-1  5.00E-7  5.00E-7  ROCK
1        1.0E-2    1800.    1.5E-2   1.5E-2   0.0
1        2        1.0
1        0.0    1.00E+6  10000.  1.00E+6

```

LISTING D-2. The PRIMOS Command
File for Test Case One.

```
EAT SEERUN

EAT SEERUN
EAT PRT
EAT RLT
COMO SEERUN
DATE
DELSEQ ALL
TIME
OPEN DATA 1 1
OPEN PRT 2 3
OPEN WORKSPACE 14 3
OPEN RLT 4 3
OPEN GEOM 7 3
OPEN VEL 10 3
SEQ SYSTEMS>FEM>MAGNUM>#MAGNUM
TIME
CLOSE WORKSPACE
EAT WORKSPACE
COMO -END
CLOSE ALL
COMO -TTY
```

3 2 1 2 4 1 3 1 7 3

LISTING D-3. Output Report File for Test Case One. (Sheet 1 of 13)

```
### ###      ####    ##### # # # # # # #  
# # # # # # # # # # # # # # # # # # # # #  
# # # # # # # # # # # # # # # # # # # # #  
# # # # # # # # # # # # # # # # # # # # #  
# # # # # # # # # # # # # # # # # # # # #  
# # # # # # # # # # # # # # # # # # # # #  
# # # # # # # # # # # # # # # # # # # # #
```

VERSION 3.0 (Revision 1.)

THU, JUL 12 1984

11:13:09

ID= 712841113

LISTING D-3. Output Report File for Test Case One. (Sheet 2 of 13)

ONE DIMENSION VERTICAL FLOW WITH HEAT GENERATION

TABLE 1. - PRINCIPAL PROBLEM SPECIFICATIONS

SIMULATION MODE (0-TIME VARYING, 1-STEADY STATE)....	0
HEAT TRANSPORT (0-ISOTHERMAL, 1-NONISOTHERMAL)....	1
GROUNDWATER FLOW (0-HYDROSTATIC, 1-FLUID FLOW)....	1
NUMBER OF NODES.....	33
NUMBER OF ELEMENTS.....	10
NUMBER OF ROCK TYPES.....	1
INITIAL CONDITION INPUTS (0-UNIFORM, 1-SPATIALLY VARYING)	1
INPUT DATA PRINT CONTROL (0-PARTIAL ECHO, 1-TOTAL ECHO)...	1
DIAGNOSTIC PRINTOUT (0-NO ACTION, 1-CONVERGENCE INFO)...	1
VELOCITY PRINT CONTROL (0-SUPPRESS PRINT, 1-PRINT VELS)...	1
RESULTS FILE WRITE CONTROL (0-AT TIME STEP, 1-AT PRT FREQ)...	0
COORD SYSTEM (0-CARTESIAN, 1-AXISYMMETRIC ABOUT X=0.)....	0
INPUT RESTART FILE (LU).....	0
REBULTS FILE (LU).....	0
OUTPUT RESTART FILE (LU).....	0
INPUT GEOMETRY FILE (LU).....	0
OUTPUT GEOMETRY FILE (LU).....	11
STREAM/PATHLINE DATA FILE (LU).....	12
TEMPERATURE INPUT FILE (TEMPERATURE INACTIVE).....	0
INITIAL CONDITION OUTPUT FILE (FORMATTED).....	0
SCALE FACTOR FOR X COORDINATES.....	1.00
SCALE FACTOR FOR Y COORDINATES.....	1.00
LEFT BOUNDARY FOR QUAD ELEMENTS.....	0.00
RIGHT BOUNDARY FOR QUAD ELEMENTS.....	0.00
TOP BOUNDARY FOR QUAD ELEMENTS.....	0.00
BOTTOM BOUNDARY FOR QUAD ELEMENTS.....	0.00
START TIME (YEARS).....	0.00
WEIGHTING FACTOR.....	1.0
DENSITY/VISCOSITY REFERENCE TEMP (>0.05 TO IMPLEMENT)...	0.0

TIME CONTROL AND RUN SPECIFICATIONS

NUMBER OF TIME STEPS	PRINT INTERVAL	TIME STEP	TIME (YEARS)
4	4	0.5000	2.000
3	3	1.000	3.000
6	6	2.500	20.00
6	6	5.000	50.00

LISTING D-3. Output Report File for Test Case One. (Sheet 3 of 13)

TABLE 2. - NODE POINT COORDINATES

NODE	XCORD	YCORD	NODE	XCORD	YCORD	NODE	XCORD	YCORD	NODE	XCORD	YCORD	NODE	XCORD	YCORD
1	-5.00	0.00	15	3.00	27.50	29	-5.00	45.00	43	5.00	75.00	0	0.00	0.00
2	0.00	0.00	16	-5.00	30.00	30	5.00	45.00	44	-5.00	80.00	1	1.00	1.00
3	5.00	0.00	17	0.00	30.00	31	-5.00	50.00	45	5.00	80.00	2	6.00	6.00
4	-5.00	7.50	18	5.00	30.00	32	0.00	50.00	46	-5.00	85.00	3	11.00	11.00
5	5.00	7.50	19	-5.00	32.50	33	5.00	50.00	47	0.00	85.00	4	12.00	12.00
6	-5.00	15.00	20	5.00	32.50	34	-5.00	55.00	48	5.00	95.00	5	17.00	17.00
7	0.00	15.00	21	-5.00	35.00	35	5.00	56.00	49	-5.00	92.50	6	22.00	22.00
8	5.00	15.00	22	0.00	35.00	36	-5.00	62.00	50	5.00	92.50	7	27.00	27.00
9	-5.00	20.00	23	5.00	35.00	37	0.00	62.00	51	-5.00	100.00	8	32.00	32.00
10	5.00	20.00	24	-5.00	37.50	38	5.00	62.00	52	0.00	100.00	9	37.00	37.00
11	-5.00	25.00	25	5.00	37.50	39	-5.00	68.00	53	5.00	100.00	10	42.00	42.00
12	0.00	25.00	26	-5.00	40.00	40	5.00	68.00	54	0.00	100.00	11	47.00	47.00
13	5.00	25.00	27	0.00	40.00	41	-5.00	75.00	55	5.00	100.00	12	52.00	52.00
14	-5.00	27.50	28	5.00	40.00	42	0.00	75.00	56	0.00	100.00	13	57.00	57.00

TABLE 3. - ELEMENT/MODE CONNECTIVITY

ELEMENT	CONNECTIONS	TYPE	ORDER	ELEMENT	CONNECTIONS	TYPE	ORDER
1	M N1 N2 N3 N4 N5 N6 N7 N8	M	1	1	N1 N2 N3 N4 N5 N6 N7 N8	M	1
2	1 2 3 4 5 6 7 8	M	2	2	1 2 3 4 5 6 7 8	M	2
3	11 12 13 14 15 16 17 18	M	3	11 12 13 14 15 16 17 18	M	3	
4	16 17 18 19 20 21 22 23	M	4	16 17 18 19 20 21 22 23	M	4	
5	22 23 24 25 26 27 28 29	M	5	22 23 24 25 26 27 28 29	M	5	

LISTING D-3. Output Report File for Test Case One. (Sheet 4 of 13)

TABLE 4. - INITIAL CONDITIONS

NODE	T(C)	H(M)	NODE	T(C)	H(M)	NODE	T(C)	H(M)
1	52.00	1.00	19	52.00	0.67	37	52.00	0.38
2	52.00	1.00	20	52.00	0.67	38	52.00	0.38
3	52.00	1.00	21	52.00	0.65	39	52.00	0.31
4	52.00	0.92	22	52.00	0.65	40	52.00	0.31
5	52.00	0.92	23	52.00	0.65	41	52.00	0.25
6	52.00	0.85	24	52.00	0.63	42	52.00	0.25
7	52.00	0.85	25	52.00	0.63	43	52.00	0.25
8	52.00	0.85	26	52.00	0.60	44	52.00	0.20
9	52.00	0.80	27	52.00	0.60	45	52.00	0.20
10	52.00	0.80	28	52.00	0.60	46	52.00	0.15
11	52.00	0.75	29	52.00	0.55	47	52.00	0.15
12	52.00	0.75	30	52.00	0.55	48	52.00	0.15
13	52.00	0.75	31	52.00	0.50	49	52.00	0.07
14	52.00	0.72	32	52.00	0.50	50	52.00	0.07
15	52.00	0.72	33	52.00	0.50	51	52.00	0.00
16	52.00	0.70	34	52.00	0.44	52	52.00	0.00
17	52.00	0.70	35	52.00	0.44	53	52.00	0.00
18	52.00	0.70	36	52.00	0.38			

TABLE 5. - SPECIFIED BOUNDARY CONDITIONS

NUMBER OF SPECIFIED BOUNDARY NODES

6

NODE	TYPE	T(C)	H(M)
1 (01)		52.000	1.000
2 (01)		52.000	1.000
3 (01)		52.000	1.000
51 (11)		52.000	0.000
52 (11)		52.000	0.000
53 (11)		52.000	0.000

LISTING D-3. Output Report File for Test Case One. (Sheet 5 of 13)

TABLE 6. - ROCK PROPERTIES

PARAMETER	ROCK 1	ROCK TYPES
1. SPECIFIC HEAT (J/KG-C)	1. 000E+03	
2. THERMAL CONDUCTIVITY IN X (J/SEC-M-C)	2. 000E-01	
3. THERMAL CONDUCTIVITY IN Y (J/SEC-M-C)	2. 000E-01	
4. EFFECTIVE POROSITY (FRACTION)	1. 000E-01	
5. HYDRAULIC CONDUCTIVITY (KXX-M/SEC)	5. 000E-07	
6. HYDRAULIC CONDUCTIVITY (KZZ-M/SEC)	5. 000E-07	
7. SPECIFIC STORAGE (1/M)	1. 000E-02	
8. ROCK DENSITY (KG/M#3)	1. 000E+03	
9. LONGITUDINAL DISPERSIVITY (M)	1. 000E-02	
10. LATERAL DISPERSIVITY (M)	1. 000E-02	
11. FRACTURE/FAULT THICKNESS (M)	0. 000E-01	

LISTING D-3. Output Report File for Test Case One. (Sheet 6 of 13)

TABLE 7. - HEAT GENERATION HISTORY

NUMBER OF HEAT SOURCE ELEMENTS..... 1
 NUMBER OF TIME POINTS..... 2
 SCALE FACTOR FOR HEAT LOAD..... 1.00

HEAT SOURCE ELEMENT NUMBER

1

TIME (YR)	THERMAL LOAD (J/YR-M**3)
0.000	0.100E+07
0.100E+03	0.100E+07

D-23

ONE DIMENSION VERTICAL FLOW WITH HEAT GENERATION

RESULTS ON YEAR 2.000

NODE	T(C)	H(M)	*	NODE	T(C)	H(M)	*	NODE	T(C)	H(M)	*
1	52.80	1.000	*	19	52.00	0.6793		37	52.00	0.3818	
2	52.80	1.000	*	20	52.00	0.6793		38	52.00	0.3818	
3	52.80	1.000	*	21	52.00	0.6540		39	52.00	0.3164	
4	52.90	0.9281		22	52.00	0.6540		40	52.00	0.3164	
5	52.90	0.9281		23	52.00	0.6540		41	52.00	0.2511	
6	52.49	0.8556		24	52.00	0.6288		42	52.00	0.2511	
7	52.49	0.8556		25	52.00	0.6288		43	52.00	0.2511	
8	52.49	0.8556		26	52.00	0.6035		44	52.00	0.2008	
9	52.04	0.8056		27	52.00	0.6035		45	52.00	0.2008	
10	52.04	0.8056		28	52.00	0.6035		46	52.00	0.1506	
11	52.01	0.7551		29	52.00	0.5531		47	52.00	0.1506	
12	52.01	0.7551		30	52.00	0.5531		48	52.00	0.1506	
13	52.01	0.7551		31	52.00	0.5027		49	52.00	0.7530E-01	
14	52.01	0.7298		32	52.00	0.5027		50	52.00	0.7530E-01	
15	52.01	0.7298		33	52.00	0.5027		51	52.00	* 0.0000	*
16	52.00	0.7046		34	52.00	0.4422		52	52.00	* 0.0000	*
17	52.00	0.7046		35	52.00	0.4422		53	52.00	* 0.0000	*
18	52.00	0.7046		36	52.00	0.3818					

ITERATION NUMBER 1. MAX REL CHANGE (TEMP) = 4.6735E-03, MAX REL CORRECTION = 4.6107E-05
 ITERATION NUMBER 1. MAX REL CHANGE (HEAD) = 2.4432E-03, MAX REL CORRECTION = 1.2964E-03

LISTING D-3. Output Report File for Test Case One. (Sheet 7 of 13)

ONE DIMENSION VERTICAL FLOW WITH HEAT GENERATION

RESULTS FOR VELOCITY (M/YR) OF YEAR 2.000

ELEMENT		QSS PNT 1	QSS PNT 2	QSS PNT 3	QSS PNT 4	QSS PNT 5	QSS PNT 6	QSS PNT 7	QSS PNT 8	QSS PNT 9	QSS PNT 9
1	VEL X	-4.3931E-13	1.1337E-13	3.1177E-13	-2.1257E-13	2.8342E-14	2.5508E-13	-2.5508E-13	-1.4171E-14	-1.4171E-13	
	VEL Y	1.5954E-01	1.5954E-01	1.5954E-01	1.6076E-01	1.6076E-01	1.6076E-01	1.5954E-01	1.5954E-01	1.5954E-01	1.5954E-01
2	VEL X	-1.4122E-12	6.3233E-14	1.2364E-12	-1.0117E-12	-4.2156E-14	9.4147E-13	-5.4100E-13	8.4311E-14	3.8643E-13	
	VEL Y	1.6016E-01	1.6016E-01	1.6016E-01	1.5930E-01	1.5930E-01	1.5930E-01	1.6045E-01	1.6045E-01	1.6045E-01	1.6045E-01
3	VEL X	3.5016E-15	5.2524E-14	-1.8559E-13	-5.6026E-13	4.2019E-14	6.8632E-13	-1.2746E-12	1.0855E-13	1.2081E-12	
	VEL Y	1.5949E-01	1.5949E-01	1.5949E-01	1.5956E-01	1.5956E-01	1.5956E-01	1.5964E-01	1.5964E-01	1.5964E-01	1.5964E-01
4	VEL X	-1.4005E-14	6.6524E-14	-1.5055E-13	1.2605E-13	2.8010E-14	-8.4030E-14	1.8907E-13	3.1511E-14	-3.4663E-13	
	VEL Y	1.5934E-01	1.5934E-01	1.5934E-01	1.5940E-01	1.5940E-01	1.5940E-01	1.5946E-01	1.5946E-01	1.5946E-01	1.5946E-01
5	VEL X	1.7506E-14	1.0504E-13	-2.8010E-14	2.8010E-14	4.2014E-14	8.4029E-14	-4.5516E-14	4.2014E-14	-9.4532E-14	
	VEL Y	1.5919E-01	1.5919E-01	1.5919E-01	1.5925E-01	1.5925E-01	1.5925E-01	1.5930E-01	1.5930E-01	1.5930E-01	1.5930E-01
6	VEL X	-7.0024E-15	6.6523E-14	-2.1007E-14	-3.5012E-14	-1.4005E-14	2.8010E-14	-1.0504E-14	6.6523E-14	-6.3022E-14	
	VEL Y	1.5895E-01	1.5895E-01	1.5895E-01	1.5905E-01	1.5905E-01	1.5905E-01	1.5915E-01	1.5915E-01	1.5915E-01	1.5915E-01
7	VEL X	-4.5516E-14	5.6019E-14	-5.6019E-14	-2.8010E-14	-6.3022E-14	2.8010E-14	-1.7506E-14	5.2518E-14	2.8010E-14	
	VEL Y	1.5889E-01	1.5889E-01	1.5889E-01	1.5879E-01	1.5879E-01	1.5879E-01	1.5889E-01	1.5889E-01	1.5889E-01	1.5889E-01
8	VEL X	-1.4005E-14	9.3261E-14	-1.7506E-14	-2.1007E-14	-2.1007E-14	-1.4005E-14	1.7504E-14	6.6523E-14	1.9257E-14	
	VEL Y	1.5848E-01	1.5848E-01	1.5848E-01	1.5856E-01	1.5856E-01	1.5856E-01	1.5864E-01	1.5864E-01	1.5864E-01	1.5864E-01
9	VEL X	-1.5755E-14	2.4508E-14	-2.4508E-14	-1.0504E-14	-1.4005E-14	3.5012E-15	7.0024E-15	4.5516E-14	1.7506E-15	
	VEL Y	1.5837E-01	1.5837E-01	1.5837E-01	1.5841E-01	1.5841E-01	1.5841E-01	1.5845E-01	1.5845E-01	1.5845E-01	1.5845E-01
10	VEL X	-3.0635E-14	-6.1271E-15	-2.5384E-14	-8.7530E-16	8.7530E-16	6.1271E-15	1.6193E-14	3.7200E-14	8.3153E-15	
	VEL Y	1.5831E-01	1.5831E-01	1.5831E-01	1.5833E-01	1.5833E-01	1.5833E-01	1.5835E-01	1.5835E-01	1.5835E-01	1.5835E-01

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RHO-BW-CR-143 P

2 1 1 2 4 1 3 1 4 3 0

LISTING D-3. Output Report File for Test Case One. (Sheet 8 of 13)

ONE DIMENSION VERTICAL FLOW WITH HEAT GENERATION

RESULTS ON YEAR 5.000

NODE	T(C)	H(M)	NODE	T(C)	H(M)	NODE	T(C)	H(M)	
1	54.24	1.000	*	19	52.00	0.6899	37	52.00	0.3877
2	54.24	1.000	*	20	52.00	0.6899	38	52.00	0.3877
3	54.24	1.000	*	21	52.00	0.6642	39	52.00	0.3213
4	54.31	0.9341		22	52.00	0.6642	40	52.00	0.3213
5	54.31	0.9341		23	52.00	0.6642	41	52.00	0.2549
6	53.35	0.8665		24	52.00	0.6385	42	52.00	0.2549
7	53.35	0.8665		25	52.00	0.6385	43	52.00	0.2549
8	53.35	0.8665		26	52.00	0.6129	44	52.00	0.2039
9	52.37	0.8175		27	52.00	0.6129	45	52.00	0.2039
10	52.37	0.8175		28	52.00	0.6129	46	52.00	0.1529
11	52.06	0.7669		29	52.00	0.5616	47	52.00	0.1529
12	52.06	0.7669		30	52.00	0.5616	48	52.00	0.1529
13	52.06	0.7669		31	52.00	0.5104	49	52.00	0.7646E-01
14	52.03	0.7412		32	52.00	0.5104	50	52.00	0.7646E-01
15	52.03	0.7412		33	52.00	0.5104	51	52.00	* 0.0000 *
16	52.01	0.7155		34	52.00	0.4490	52	52.00	* 0.0000 *
17	52.01	0.7155		35	52.00	0.4490	53	52.00	* 0.0000 *
18	52.01	0.7155		36	52.00	0.3877			

ITERATION NUMBER 1, MAX REL CHANGE (TEMP) = 9.0616E-03, MAX REL CORRECTION = 1.0331E-04
 ITERATION NUMBER 1, MAX REL CHANGE (HEAD) = 5.3353E-03, MAX REL CORRECTION = 5.7984E-04

LISTING D-3. Output Report File for Test Case One. (Sheet 9 of 13)

ONE DIMENSION VERTICAL FLOW WITH HEAT GENERATION

RESULTS FOR VELOCITY (M/YR) OF YEAR 5.000

ELEMENT		QSS PNT 1	QSS PNT 2	QSS PNT 3	QSS PNT 4	QSS PNT 5	QSS PNT 6	QSS PNT 7	QSS PNT 8	QSS PNT 9
1	VEL X	-3.4673E-13	1.3002E-13	2.4560E-13	-1.4447E-13	5.7788E-14	2.1670E-13	-2.5282E-13	-2.1671E-14	-1.3169E-13
	VEL Y	1.6149E-01	1.6149E-01	1.6149E-01	1.6407E-01	1.6407E-01	1.6407E-01	1.6143E-01	1.6143E-01	1.6143E-01
2	VEL X	-7.7825E-14	1.2735E-13	1.4150E-14	-2.1225E-13	-4.2450E-14	1.5565E-13	-3.6082E-13	9.1974E-14	1.8395E-13
	VEL Y	1.6314E-01	1.6314E-01	1.6314E-01	1.6158E-01	1.6158E-01	1.6158E-01	1.6337E-01	1.6337E-01	1.6337E-01
3	VEL X	-1.2612E-13	3.5032E-15	-1.7516E-13	-7.0065E-14	-2.8026E-14	-1.4013E-14	-7.0065E-15	1.2942E-13	3.5032E-15
	VEL Y	1.6216E-01	1.6216E-01	1.6216E-01	1.6219E-01	1.6219E-01	1.6219E-01	1.6233E-01	1.6233E-01	1.6233E-01
4	VEL X	3.1164E-13	1.2606E-13	-2.6962E-13	2.1009E-13	8.4037E-14	-9.6025E-14	-1.4006E-14	3.5016E-14	-1.2606E-13
	VEL Y	1.6192E-01	1.6192E-01	1.6192E-01	1.6199E-01	1.6199E-01	1.6199E-01	1.6208E-01	1.6208E-01	1.6208E-01
5	VEL X	3.5013E-15	9.8035E-14	2.1008E-14	1.4005E-14	-7.0025E-14	-1.6806E-13	2.1358E-13	3.8514E-14	-3.8514E-13
	VEL Y	1.6174E-01	1.6174E-01	1.6174E-01	1.6181E-01	1.6181E-01	1.6181E-01	1.6188E-01	1.6188E-01	1.6188E-01
6	VEL X	-3.5012E-14	4.2014E-14	-6.6523E-14	-7.0024E-14	-2.1007E-14	4.2014E-14	-3.5012E-14	1.2954E-13	6.3022E-14
	VEL Y	1.6145E-01	1.6145E-01	1.6145E-01	1.6157E-01	1.6157E-01	1.6157E-01	1.6168E-01	1.6168E-01	1.6168E-01
7	VEL X	-4.9017E-14	4.9017E-14	-6.3022E-14	2.1007E-14	-2.8010E-14	3.5012E-14	-1.0504E-14	4.5516E-14	2.1007E-14
	VEL Y	1.6116E-01	1.6116E-01	1.6116E-01	1.6127E-01	1.6127E-01	1.6127E-01	1.6138E-01	1.6138E-01	1.6138E-01
8	VEL X	-1.7506E-14	3.3261E-14	-3.1511E-14	-7.0024E-15	-7.0024E-15	7.0024E-15	-7.0024E-15	4.5516E-14	-3.5012E-15
	VEL Y	1.6093E-01	1.6093E-01	1.6093E-01	1.6101E-01	1.6101E-01	1.6101E-01	1.6110E-01	1.6110E-01	1.6110E-01
9	VEL X	-7.0024E-15	2.2758E-14	-3.6763E-14	-1.4005E-14	-1.4005E-14	0.0000E-01	0.0000E-01	3.6763E-14	-2.4508E-14
	VEL Y	1.6081E-01	1.6081E-01	1.6081E-01	1.6085E-01	1.6085E-01	1.6085E-01	1.6089E-01	1.6089E-01	1.6089E-01
10	VEL X	-2.9323E-14	-4.8141E-15	-2.5384E-14	0.0000E-01	1.7506E-15	5.2518E-15	1.7068E-14	3.2824E-14	-1.3129E-15
	VEL Y	1.6074E-01	1.6074E-01	1.6074E-01	1.6076E-01	1.6076E-01	1.6076E-01	1.6078E-01	1.6078E-01	1.6078E-01

1 2 3 4 5 6 7 8

LISTING D-3. Output Report File for Test Case One. (Sheet 10 of 13)

ONE DIMENSION VERTICAL FLOW WITH HEAT GENERATION

RESULTS ON YEAR 20.00

NODE	T(C)	H(M)	NODE	T(C)	H(M)	NODE	T(C)	H(M)	
1	61.22	1.000	*	19	52.67	0.7547	37	52.00	0.4253
2	61.22	1.000	*	20	52.67	0.7547	38	52.00	0.4253
3	61.22	1.000	*	21	52.44	0.7275	39	52.00	0.3525
4	60.82	0.9630		22	52.44	0.7275	40	52.00	0.3525
5	60.82	0.9630		23	52.44	0.7275	41	52.00	0.2797
6	58.24	0.9193		24	52.28	0.6998	42	52.00	0.2797
7	58.24	0.9193		25	52.28	0.6998	43	52.00	0.2797
8	58.24	0.9193		26	52.17	0.6721	44	52.00	0.2237
9	55.71	0.8792		27	52.17	0.6721	45	52.00	0.2237
10	55.71	0.8792		28	52.17	0.6721	46	52.00	0.1677
11	54.01	0.8331		29	52.06	0.6161	47	52.00	0.1677
12	54.01	0.8331		30	52.06	0.6161	48	52.00	0.1677
13	54.01	0.8331		31	52.02	0.5600	49	52.00	0.8386E-01
14	53.43	0.8077		32	52.02	0.5600	50	52.00	0.8386E-01
15	53.43	0.8077		33	52.02	0.5600	51	52.00	* 0.0000 *
16	52.99	0.7816		34	52.01	0.4926	52	52.00	* 0.0000 *
17	52.99	0.7816		35	52.01	0.4926	53	52.00	* 0.0000 *
18	52.99	0.7816		36	52.00	0.4253			

ITERATION NUMBER 1. MAX REL CHANGE (TEMP) = 1.8530E-02, MAX REL CORRECTION = 2.8225E-04
 ITERATION NUMBER 1. MAX REL CHANGE (HEAD) = 1.7283E-02, MAX REL CORRECTION = 2.7608E-04

LISTING D-3. Output Report File for Test Case One. (Sheet 11 of 13)

ONE DIMENSION VERTICAL FLOW WITH HEAT GENERATION

RESULTS FOR VELOCITY (M/YR) OF YEAR 20.00

ELEMENT		QSS PNT 1	QSS PNT 2	QSS PNT 3	QSS PNT 4	QSS PNT 5	QSS PNT 6	QSS PNT 7	QSS PNT 8	QSS PNT 9
1	VEL X	6.2666E-14	1.4883E-13	-1.1750E-13	0.0000E-01	1.5667E-14	-6.2666E-14	-2.5057E-13	-4.7000E-14	-2.3500E-13
	VEL Y	1.7559E-01	1.7559E-01	1.7559E-01	1.8245E-01	1.8245E-01	1.8245E-01	1.7547E-01	1.7547E-01	1.7547E-01
2	VEL X	-2.0087E-13	5.2076E-14	2.2318E-14	-5.9516E-14	-2.9758E-14	7.4394E-14	1.2647E-13	1.3391E-13	-8.9273E-14
	VEL Y	1.7974E-01	1.7974E-01	1.7974E-01	1.7713E-01	1.7713E-01	1.7713E-01	1.7990E-01	1.7990E-01	1.7990E-01
3	VEL X	0.0000E-01	1.4348E-13	-1.4348E-14	-7.1740E-14	-1.4348E-14	1.0044E-13	-2.1522E-13	5.7392E-14	2.1522E-14
	VEL Y	1.7849E-01	1.7849E-01	1.7849E-01	1.7819E-01	1.7819E-01	1.7819E-01	1.7864E-01	1.7864E-01	1.7864E-01
4	VEL X	0.0000E-01	1.0981E-13	-4.9594E-14	-5.6678E-14	-5.6678E-14	-2.8339E-14	-7.0848E-15	1.0627E-13	-1.1336E-13
	VEL Y	1.7819E-01	1.7819E-01	1.7819E-01	1.7805E-01	1.7805E-01	1.7805E-01	1.7837E-01	1.7837E-01	1.7837E-01
5	VEL X	-4.5744E-14	5.9822E-14	-9.5011E-14	2.8151E-14	2.8151E-14	4.2227E-14	5.6303E-14	1.4780E-13	-7.0379E-15
	VEL Y	1.7788E-01	1.7788E-01	1.7788E-01	1.7785E-01	1.7785E-01	1.7785E-01	1.7807E-01	1.7807E-01	1.7807E-01
6	VEL X	-4.9091E-14	4.9091E-14	-1.1221E-13	-1.4026E-14	-7.0130E-15	1.4026E-14	-6.3117E-14	4.3584E-14	-1.0169E-13
	VEL Y	1.7743E-01	1.7743E-01	1.7743E-01	1.7745E-01	1.7745E-01	1.7745E-01	1.7779E-01	1.7779E-01	1.7779E-01
7	VEL X	-3.1516E-14	7.0035E-14	-4.9025E-14	7.0035E-15	-2.8014E-14	4.2021E-14	-2.8014E-14	3.5018E-14	-3.1516E-14
	VEL Y	1.7692E-01	1.7692E-01	1.7692E-01	1.7705E-01	1.7705E-01	1.7705E-01	1.7725E-01	1.7725E-01	1.7725E-01
8	VEL X	-7.0025E-15	5.6020E-14	-1.0504E-14	-4.2015E-14	-2.8010E-14	-1.4003E-14	-7.0025E-15	3.9521E-14	-1.7506E-15
	VEL Y	1.7657E-01	1.7657E-01	1.7657E-01	1.7669E-01	1.7669E-01	1.7669E-01	1.7682E-01	1.7682E-01	1.7682E-01
9	VEL X	3.5012E-15	4.3765E-14	-1.0504E-14	-5.2518E-14	-4.9017E-14	-3.8513E-14	1.4005E-14	5.0767E-14	-3.5012E-15
	VEL Y	1.7640E-01	1.7640E-01	1.7640E-01	1.7646E-01	1.7646E-01	1.7646E-01	1.7652E-01	1.7652E-01	1.7652E-01
10	VEL X	-4.5078E-14	-1.6631E-14	-3.8513E-14	-1.2254E-14	-1.2254E-14	-8.7530E-15	5.4269E-14	7.0024E-14	3.3699E-14
	VEL Y	1.7630E-01	1.7630E-01	1.7630E-01	1.7633E-01	1.7633E-01	1.7633E-01	1.7636E-01	1.7636E-01	1.7636E-01

2 2 1 2 1 1 1 2 3 4

LISTING D-3. Output Report File for Test Case One. (Sheet 12 of 13)

ONE DIMENSION VERTICAL FLOW WITH HEAT GENERATION

RESULTS ON YEAR 50.00

NODE	T(C)	H(M)	NODE	T(C)	H(M)	NODE	T(C)	H(M)	
1	73.97	1.000	*	19	58.66	0.9188	37	52.42	0.5458
2	73.97	1.000	*	20	58.66	0.9188	38	52.42	0.5458
3	73.97	1.000	*	21	57.58	0.8940	39	52.19	0.4531
4	73.39	1.014		22	57.58	0.8940	40	52.19	0.4531
5	73.39	1.014		23	57.58	0.8940	41	52.08	0.3599
6	69.84	1.018		24	56.63	0.8668	42	52.08	0.3599
7	69.84	1.018		25	56.63	0.8668	43	52.08	0.3599
8	69.84	1.018		26	55.80	0.8384	44	52.04	0.2890
9	66.06	1.005		27	55.80	0.8384	45	52.04	0.2890
10	66.06	1.005		28	55.80	0.8384	46	52.02	0.2160
11	62.72	0.9800		29	54.48	0.7766	47	52.02	0.2160
12	62.72	0.9800		30	54.48	0.7766	48	52.02	0.2160
13	62.72	0.9800		31	53.55	0.7119	49	52.01	0.1080
14	61.23	0.9621		32	53.55	0.7119	50	52.01	0.1080
15	61.23	0.9621		33	53.55	0.7119	51	52.00	* 0.0000 *
16	59.88	0.9419		34	52.84	0.6296	52	52.00	* 0.0000 *
17	59.88	0.9419		35	52.84	0.6296	53	52.00	* 0.0000 *
18	59.88	0.9419		36	52.42	0.5458			

ITERATION NUMBER 1. MAX REL CHANGE (TEMP) = 3.0525E-02, MAX REL CORRECTION = 9.7269E-04
 ITERATION NUMBER 1. MAX REL CHANGE (HEAD) = 4.9591E-02, MAX REL CORRECTION = 1.1191E-03

ELEMENT 999 PNT 1 999 PNT 2 999 PNT 3 999 PNT 4 999 PNT 5 999 PNT 6 999 PNT 7 999 PNT 8 999 PNT 9

REBULITIS FOR VELOCITY (M/VR) OF VEAR 50.00

ONE DIMENGINON VERTICLAL FLOW WITH HEAT GENERATION

LISTING D-3. Output Report File for Test Case One. (Sheet 13 of 13)

LISTING D-4. Input Data File for Test Case Two. (Sheet 1 of 6)

SAMPLE PROBLEM. FLOW AROUND A HEATED CANNISTER

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SAMPLE PROBLEM. FLOW AROUND A HEATED CANNISTER
      0   1   1   445   136   3   1   1   1   1   0   0   /*CNTRL
      0   8   0   11   0   13   0
      0.           1.5       50.0   /*FILE UNITS
      5   5   0.20   /*STRT TME
      4   4   1.00
      2   2   2.50
9999
      1.0   1.0   /*SCALE
      1 5.00E+01 1.20E+00   /*IC
      2 5.000E+01 1.200E+00
      3 5.000E+01 1.200E+00
      4 5.000E+01 1.200E+00
      5 5.000E+01 1.200E+00
      6 5.000E+01 1.200E+00
      7 5.000E+01 1.200E+00
      8 5.000E+01 1.200E+00
      9 5.000E+01 1.200E+00
     10 5.000E+01 1.200E+00
     11 5.000E+01 1.200E+00
     12 5.000E+01 1.200E+00
     13 5.000E+01 1.200E+00
     14 5.000E+01 1.200E+00
     15 5.000E+01 1.200E+00
     16 5.000E+01 1.190E+00
     17 5.000E+01 1.179E+00
     18 5.000E+01 1.179E+00
     19 5.000E+01 1.179E+00
     20 5.000E+01 1.190E+00
     21 5.000E+01 1.190E+00
     22 5.000E+01 1.179E+00
     23 5.000E+01 1.179E+00
     24 5.000E+01 1.190E+00
     25 5.000E+01 1.179E+00
     26 5.000E+01 1.179E+00
     27 5.000E+01 1.190E+00
     28 5.000E+01 1.180E+00
     29 5.000E+01 1.179E+00
     30 5.000E+01 1.190E+00
     31 5.000E+01 1.180E+00
     32 5.000E+01 1.180E+00
     33 5.000E+01 1.190E+00
     34 5.000E+01 1.180E+00
     35 5.000E+01 1.180E+00
     36 5.000E+01 1.190E+00
     37 5.000E+01 1.180E+00
     38 5.000E+01 1.180E+00
     39 5.000E+01 1.169E+00
     40 5.000E+01 1.158E+00
     41 5.000E+01 1.158E+00
     42 5.000E+01 1.158E+00
     43 5.000E+01 1.169E+00
     44 5.000E+01 1.169E+00

```

LISTING D-4. Input Data File for Test Case Two. (Sheet 2 of 6)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

45 5.000E+01	1. 159E+00	98 5.000E+01	1. 123E+00
46 5.000E+01	1. 158E+00	99 5.000E+01	1. 123E+00
47 5.000E+01	1. 169E+00	100 5.000E+01	1. 131E+00
48 5.000E+01	1. 159E+00	101 5.000E+01	1. 124E+00
49 5.000E+01	1. 159E+00	102 5.000E+01	1. 124E+00
50 5.000E+01	1. 169E+00	103 5.000E+01	1. 132E+00
51 5.000E+01	1. 159E+00	104 5.000E+01	1. 125E+00
52 5.000E+01	1. 159E+00	105 5.000E+01	1. 125E+00
53 5.000E+01	1. 170E+00	106 5.000E+01	1. 132E+00
54 5.000E+01	1. 160E+00	107 5.000E+01	1. 126E+00
55 5.000E+01	1. 159E+00	108 5.000E+01	1. 126E+00
56 5.000E+01	1. 170E+00	109 5.000E+01	1. 132E+00
57 5.000E+01	1. 160E+00	110 5.000E+01	1. 126E+00
58 5.000E+01	1. 160E+00	111 5.000E+01	1. 126E+00
59 5.000E+01	1. 170E+00	112 5.000E+01	1. 109E+00
60 5.000E+01	1. 160E+00	113 5.000E+01	1. 115E+00
61 5.000E+01	1. 160E+00	114 5.000E+01	1. 115E+00
62 5.000E+01	1. 148E+00	115 5.000E+01	1. 109E+00
63 5.000E+01	1. 137E+00	116 5.000E+01	1. 109E+00
64 5.000E+01	1. 137E+00	117 5.000E+01	1. 114E+00
65 5.000E+01	1. 137E+00	118 5.000E+01	1. 108E+00
66 5.000E+01	1. 148E+00	119 5.000E+01	1. 108E+00
67 5.000E+01	1. 148E+00	120 5.000E+01	1. 116E+00
68 5.000E+01	1. 137E+00	121 5.000E+01	1. 111E+00
69 5.000E+01	1. 137E+00	122 5.000E+01	1. 109E+00
70 5.000E+01	1. 148E+00	123 5.000E+01	1. 118E+00
71 5.000E+01	1. 138E+00	124 5.000E+01	1. 113E+00
72 5.000E+01	1. 138E+00	125 5.000E+01	1. 112E+00
73 5.000E+01	1. 149E+00	126 5.000E+01	1. 119E+00
74 5.000E+01	1. 139E+00	127 5.000E+01	1. 114E+00
75 5.000E+01	1. 138E+00	128 5.000E+01	1. 114E+00
76 5.000E+01	1. 150E+00	129 5.000E+01	1. 120E+00
77 5.000E+01	1. 140E+00	130 5.000E+01	1. 115E+00
78 5.000E+01	1. 139E+00	131 5.000E+01	1. 115E+00
79 5.000E+01	1. 150E+00	132 5.000E+01	1. 120E+00
80 5.000E+01	1. 140E+00	133 5.000E+01	1. 115E+00
81 5.000E+01	1. 140E+00	134 5.000E+01	1. 115E+00
82 5.000E+01	1. 150E+00	135 5.000E+01	1. 120E+00
83 5.000E+01	1. 140E+00	136 5.000E+01	1. 115E+00
84 5.000E+01	1. 140E+00	137 5.000E+01	1. 115E+00
85 5.000E+01	1. 130E+00	138 5.000E+01	1. 097E+00
86 5.000E+01	1. 122E+00	139 5.000E+01	1. 102E+00
87 5.000E+01	1. 129E+00	140 5.000E+01	1. 103E+00
88 5.000E+01	1. 129E+00	141 5.000E+01	1. 097E+00
89 5.000E+01	1. 121E+00	142 5.000E+01	1. 097E+00
90 5.000E+01	1. 122E+00	143 5.000E+01	1. 102E+00
91 5.000E+01	1. 129E+00	144 5.000E+01	1. 098E+00
92 5.000E+01	1. 122E+00	145 5.000E+01	1. 097E+00
93 5.000E+01	1. 122E+00	146 5.000E+01	1. 106E+00
94 5.000E+01	1. 122E+00	147 5.000E+01	1. 104E+00
95 5.000E+01	1. 122E+00	148 5.000E+01	1. 101E+00
96 5.000E+01	1. 129E+00	149 5.000E+01	1. 109E+00
97 5.000E+01	1. 130E+00	150 5.000E+01	1. 106E+00

LISTING D-4. Input Data File for Test Case Two. (Sheet 3 of 6)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

151	5.000E+01	1.105E+00	204	5.000E+01	1.099E+00
152	5.000E+01	1.110E+00	205	5.000E+01	1.099E+00
153	5.000E+01	1.107E+00	206	5.000E+01	1.099E+00
154	5.000E+01	1.107E+00	207	5.000E+01	1.100E+00
155	5.000E+01	1.111E+00	208	5.000E+01	1.099E+00
156	5.000E+01	1.108E+00	209	5.000E+01	1.101E+00
157	5.000E+01	1.108E+00	210	5.000E+01	1.100E+00
158	5.000E+01	1.111E+00	211	5.000E+01	1.100E+00
159	5.000E+01	1.106E+00	212	5.000E+01	1.100E+00
160	5.000E+01	1.108E+00	213	5.000E+01	1.099E+00
161	5.000E+01	1.111E+00	214	5.000E+01	1.100E+00
162	5.000E+01	1.108E+00	215	5.000E+01	1.102E+00
163	5.000E+01	1.108E+00	216	5.000E+01	1.100E+00
164	5.000E+01	1.097E+00	217	5.000E+01	1.100E+00
165	5.000E+01	1.097E+00	218	5.000E+01	1.100E+00
166	5.000E+01	1.097E+00	219	5.000E+01	1.099E+00
167	5.000E+01	1.097E+00	220	5.000E+01	1.100E+00
168	5.000E+01	1.097E+00	221	5.000E+01	1.100E+00
169	5.000E+01	1.098E+00	222	5.000E+01	1.098E+00
170	5.000E+01	1.098E+00	223	5.000E+01	1.096E+00
171	5.000E+01	1.098E+00	224	5.000E+01	1.098E+00
172	5.000E+01	1.099E+00	225	5.000E+01	1.095E+00
173	5.000E+01	1.098E+00	226	5.000E+01	1.093E+00
174	5.000E+01	1.103E+00	227	5.000E+01	1.095E+00
175	5.000E+01	1.102E+00	228	5.000E+01	1.095E+00
176	5.000E+01	1.101E+00	229	5.000E+01	1.092E+00
177	5.000E+01	1.099E+00	230	5.000E+01	1.092E+00
178	5.000E+01	1.098E+00	231	5.000E+01	1.095E+00
179	5.000E+01	1.099E+00	232	5.000E+01	1.092E+00
180	5.000E+01	1.105E+00	233	5.000E+01	1.092E+00
181	5.000E+01	1.104E+00	234	5.000E+01	1.095E+00
182	5.000E+01	1.103E+00	235	5.000E+01	1.092E+00
183	5.000E+01	1.105E+00	236	5.000E+01	1.092E+00
184	5.000E+01	1.100E+00	237	5.000E+01	1.099E+00
185	5.000E+01	1.102E+00	238	5.000E+01	1.098E+00
186	5.000E+01	1.105E+00	239	5.000E+01	1.098E+00
187	5.000E+01	1.105E+00	240	5.000E+01	1.099E+00
188	5.000E+01	1.100E+00	241	5.000E+01	1.099E+00
189	5.000E+01	1.100E+00	242	5.000E+01	1.099E+00
190	5.000E+01	1.105E+00	243	5.000E+01	1.100E+00
191	5.000E+01	1.100E+00	244	5.000E+01	1.099E+00
192	5.000E+01	1.100E+00	245	5.000E+01	1.100E+00
193	5.000E+01	1.105E+00	246	5.000E+01	1.099E+00
194	5.000E+01	1.100E+00	247	5.000E+01	1.098E+00
195	5.000E+01	1.100E+00	248	5.000E+01	1.099E+00
196	5.000E+01	1.098E+00	249	5.000E+01	1.101E+00
197	5.000E+01	1.097E+00	250	5.000E+01	1.101E+00
198	5.000E+01	1.098E+00	251	5.000E+01	1.101E+00
199	5.000E+01	1.098E+00	252	5.000E+01	1.101E+00
200	5.000E+01	1.098E+00	253	5.000E+01	1.101E+00
201	5.000E+01	1.098E+00	254	5.000E+01	1.097E+00
202	5.000E+01	1.098E+00	255	5.000E+01	1.101E+00
203	5.000E+01	1.098E+00	256	5.000E+01	1.101E+00

LISTING D-4. Input Data File for Test Case Two. (Sheet 4 of 6)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

257 5.000E+01 1. 101E+00	310 5.000E+01 1. 076E+00
258 5.000E+01 1. 101E+00	311 5.000E+01 1. 077E+00
259 5.000E+01 1. 101E+00	312 5.000E+01 1. 082E+00
260 5.000E+01 1. 101E+00	313 5.000E+01 1. 080E+00
261 5.000E+01 1. 093E+00	314 5.000E+01 1. 075E+00
262 5.000E+01 1. 094E+00	315 5.000E+01 1. 075E+00
263 5.000E+01 1. 095E+00	316 5.000E+01 1. 077E+00
264 5.000E+01 1. 095E+00	317 5.000E+01 1. 078E+00
265 5.000E+01 1. 096E+00	318 5.000E+01 1. 084E+00
266 5.000E+01 1. 097E+00	319 5.000E+01 1. 080E+00
267 5.000E+01 1. 090E+00	320 5.000E+01 1. 074E+00
268 5.000E+01 1. 086E+00	321 5.000E+01 1. 074E+00
269 5.000E+01 1. 086E+00	322 5.000E+01 1. 080E+00
270 5.000E+01 1. 087E+00	323 5.000E+01 1. 074E+00
271 5.000E+01 1. 091E+00	324 5.000E+01 1. 074E+00
272 5.000E+01 1. 089E+00	325 5.000E+01 1. 103E+00
273 5.000E+01 1. 085E+00	326 5.000E+01 1. 103E+00
274 5.000E+01 1. 085E+00	327 5.000E+01 1. 092E+00
275 5.000E+01 1. 089E+00	328 5.000E+01 1. 091E+00
276 5.000E+01 1. 085E+00	329 5.000E+01 1. 097E+00
277 5.000E+01 1. 085E+00	330 5.000E+01 1. 103E+00
278 5.000E+01 1. 089E+00	331 5.000E+01 1. 102E+00
279 5.000E+01 1. 085E+00	332 5.000E+01 1. 103E+00
280 5.000E+01 1. 085E+00	333 5.000E+01 1. 102E+00
281 5.000E+01 1. 100E+00	334 5.000E+01 1. 103E+00
282 5.000E+01 1. 099E+00	335 5.000E+01 1. 103E+00
283 5.000E+01 1. 100E+00	336 5.000E+01 1. 103E+00
284 5.000E+01 1. 101E+00	337 5.000E+01 1. 078E+00
285 5.000E+01 1. 101E+00	338 5.000E+01 1. 079E+00
286 5.000E+01 1. 101E+00	339 5.000E+01 1. 086E+00
287 5.000E+01 1. 099E+00	340 5.000E+01 1. 078E+00
288 5.000E+01 1. 102E+00	341 5.000E+01 1. 078E+00
289 5.000E+01 1. 102E+00	342 5.000E+01 1. 085E+00
290 5.000E+01 1. 102E+00	343 5.000E+01 1. 069E+00
291 5.000E+01 1. 102E+00	344 5.000E+01 1. 061E+00
292 5.000E+01 1. 102E+00	345 5.000E+01 1. 062E+00
293 5.000E+01 1. 102E+00	346 5.000E+01 1. 062E+00
294 5.000E+01 1. 102E+00	347 5.000E+01 1. 070E+00
295 5.000E+01 1. 101E+00	348 5.000E+01 1. 068E+00
296 5.000E+01 1. 102E+00	349 5.000E+01 1. 060E+00
297 5.000E+01 1. 102E+00	350 5.000E+01 1. 061E+00
298 5.000E+01 1. 102E+00	351 5.000E+01 1. 062E+00
299 5.000E+01 1. 102E+00	352 5.000E+01 1. 063E+00
300 5.000E+01 1. 102E+00	353 5.000E+01 1. 071E+00
301 5.000E+01 1. 102E+00	354 5.000E+01 1. 068E+00
302 5.000E+01 1. 088E+00	355 5.000E+01 1. 060E+00
303 5.000E+01 1. 089E+00	356 5.000E+01 1. 060E+00
304 5.000E+01 1. 094E+00	357 5.000E+01 1. 063E+00
305 5.000E+01 1. 091E+00	358 5.000E+01 1. 063E+00
306 5.000E+01 1. 092E+00	359 5.000E+01 1. 071E+00
307 5.000E+01 1. 098E+00	360 5.000E+01 1. 068E+00
308 5.000E+01 1. 081E+00	361 5.000E+01 1. 060E+00
309 5.000E+01 1. 076E+00	362 5.000E+01 1. 060E+00

LISTING D-4. Input Data File for Test Case Two. (Sheet 5 of 6)

SAMPLE PROBLEM. FLOW AROUND A HEATED CANNISTER

SAMPLE PROBLEM. FLOW AROUND A HEATED CANNISTER

363 5.000E+01 1.103E+00	416 5.000E+01 1.031E+00
364 5.000E+01 1.103E+00	417 5.000E+01 1.030E+00
365 5.000E+01 1.091E+00	418 5.000E+01 1.020E+00
366 5.000E+01 1.091E+00	419 5.000E+01 1.020E+00
367 5.000E+01 1.098E+00	420 5.000E+01 1.021E+00
368 5.000E+01 1.103E+00	421 5.000E+01 1.031E+00
369 5.000E+01 1.078E+00	422 5.000E+01 1.021E+00
370 5.000E+01 1.078E+00	423 5.000E+01 1.010E+00
371 5.000E+01 1.085E+00	424 5.000E+01 1.000E+00
372 5.000E+01 1.070E+00	425 5.000E+01 1.000E+00
373 5.000E+01 1.063E+00	426 5.000E+01 1.000E+00
374 5.000E+01 1.071E+00	427 5.000E+01 1.010E+00
375 5.000E+01 1.063E+00	428 5.000E+01 1.010E+00
376 5.000E+01 1.071E+00	429 5.000E+01 1.000E+00
377 5.000E+01 1.051E+00	430 5.000E+01 1.000E+00
378 5.000E+01 1.041E+00	431 5.000E+01 1.000E+00
379 5.000E+01 1.041E+00	432 5.000E+01 1.000E+00
380 5.000E+01 1.041E+00	433 5.000E+01 1.010E+00
381 5.000E+01 1.052E+00	434 5.000E+01 1.010E+00
382 5.000E+01 1.050E+00	435 5.000E+01 1.000E+00
383 5.000E+01 1.040E+00	436 5.000E+01 1.000E+00
384 5.000E+01 1.041E+00	437 5.000E+01 1.000E+00
385 5.000E+01 1.041E+00	438 5.000E+01 1.000E+00
386 5.000E+01 1.041E+00	439 5.000E+01 1.010E+00
387 5.000E+01 1.052E+00	440 5.000E+01 1.010E+00
388 5.000E+01 1.050E+00	441 5.000E+01 1.000E+00
389 5.000E+01 1.040E+00	442 5.000E+01 1.000E+00
390 5.000E+01 1.040E+00	443 5.000E+01 1.000E+00
391 5.000E+01 1.042E+00	444 5.000E+01 1.010E+00
392 5.000E+01 1.042E+00	445 5.000E+01 1.000E+00
393 5.000E+01 1.052E+00	
394 5.000E+01 1.050E+00	30 1 11 5.000E+01 1.200E+00
395 5.000E+01 1.040E+00	2 11 5.000E+01 1.200E+00
396 5.000E+01 1.040E+00	3 11 5.000E+01 1.200E+00
397 5.000E+01 1.042E+00	4 11 5.000E+01 1.200E+00
398 5.000E+01 1.052E+00	5 11 5.000E+01 1.200E+00
399 5.000E+01 1.042E+00	6 11 5.000E+01 1.200E+00
400 5.000E+01 1.031E+00	7 11 5.000E+01 1.200E+00
401 5.000E+01 1.020E+00	8 11 5.000E+01 1.200E+00
402 5.000E+01 1.021E+00	9 11 5.000E+01 1.200E+00
403 5.000E+01 1.021E+00	10 11 5.000E+01 1.200E+00
404 5.000E+01 1.031E+00	11 11 5.000E+01 1.200E+00
405 5.000E+01 1.030E+00	12 11 5.000E+01 1.200E+00
406 5.000E+01 1.020E+00	13 11 5.000E+01 1.200E+00
407 5.000E+01 1.020E+00	14 11 5.000E+01 1.200E+00
408 5.000E+01 1.021E+00	15 11 5.000E+01 1.200E+00
409 5.000E+01 1.021E+00	441 11 5.000E+01 1.000E+00
410 5.000E+01 1.031E+00	442 11 5.000E+01 1.000E+00
411 5.000E+01 1.030E+00	435 11 5.000E+01 1.000E+00
412 5.000E+01 1.020E+00	436 11 5.000E+01 1.000E+00
413 5.000E+01 1.020E+00	429 11 5.000E+01 1.000E+00
414 5.000E+01 1.021E+00	430 11 5.000E+01 1.000E+00
415 5.000E+01 1.021E+00	424 11 5.000E+01 1.000E+00

/*BC

LISTING D-4. Input Data File for Test Case Two. (Sheet 6 of 6)

SAMPLE PROBLEM. FLOW AROUND A HEATED CANNISTER

```

425      11 5.000E+01 1.000E+00
426      11 5.000E+01 1.000E+00
431      11 5.000E+01 1.000E+00
432      11 5.000E+01 1.000E+00
437      11 5.000E+01 1.000E+00
438      11 5.000E+01 1.000E+00
445      11 5.000E+01 1.000E+00
443      11 5.000E+01 1.000E+00
    1    1500.0    1.500    1.500    1.0E-2    1.00E-8    1.00E-8    CANST
          1.0E-3    2500.    1.E-10    1.E-10    0.0
    2    930.0     0.800    0.800    3.0E-1    1.00E-9    1.00E-9    PCKNQ
          1.0E-3    1800.    1.E-10    1.E-10    0.0
    3    930.0     1.000    1.000    2.2E-4    1.0E-12    1.0E-12    STRESS
          1.0E-3    2700.    1.E-10    1.E-10    0.0
    8    2     1.0
/* LOAD
70   71   72   77   84   85   89   90
    0.0   1.0E+10  1000.   1.0E+10

```

LISTING D-5. The PRIMOS Command
File for Test Case Two.

```
EAT SEERUN

EAT SEERUN
EAT PRT
EAT RLT
COMO SEERUN
DATE
DELSEQ ALL
TIME
OPEN DATA 1 1
OPEN PRT 2 3
OPEN WORKSPACE 14 3
OPEN RLT 4 3
OPEN GEOM 7 1
OPEN VEL 11 3
SEQ SYSTEMS>FEM>MAGNUM>#MAGNUM
TIME
CLOSE WORKSPACE
EAT WORKSPACE
CLOSE ALL
COMO -END
COMO -TTY
```

9 2 1 2 1 1 3 1 1 2 3

LISTING D-6. Output Report File for Test Case Two. (Sheet 1 of 48)

***** ***** ***** ***** * # * ***** *****
* # * # # # # # # # # # # # # # # # # # #

#

VERSION 3.0 (Revision 1.)

FRI, JUL 20 1984

10:21:29

ID= 720841021

LISTING D-6. Output Report File for Test Case Two. (Sheet 2 of 48)

SAMPLE PROBLEM. FLOW AROUND A HEATED CANNISTER

TABLE 1. - PRINCIPAL PROBLEM SPECIFICATIONS

SIMULATION MODE (0-TIME VARYING, . NE. 0-STeady STATE).....	0
HEAT TRANSPORT (0-ISOTHERMAL, . NE. 0-NONISOTHERMAL).....	1
GROUNDWATER FLOW (0-HYDROSTATIC, . NE. 0-FLUID FLOW).....	1
NUMBER OF NODES.....	445
NUMBER OF ELEMENTS.....	136
NUMBER OF ROCK TYPES.....	3
INITIAL CONDITION INPUTS (0-UNIFORM, 1-SPATIALLY VARYING).....	1
INPUT DATA PRINT CONTROL (0-PARTIAL ECHO, 1-TOTAL ECHO).....	1
DIAGNOSTIC PRINTOUT (0-NO ACTION, 1-CONVERGENCE INFO).....	1
VELOCITY PRINT CONTROL (0-SUPPRESS PRINT, 1-PRINT VELS).....	1
RESULTS FILE WRITE CONTROL (0-AT TIME STEP, 1-AT PRT FREQ).....	0
COORD SYSTEM (0-CARTESIAN, 1-AXISYMMETRIC ABOUT X=0.).....	0
INPUT RESTART FILE (LU).....	0
RESULTS FILE (LU).....	0
OUTPUT RESTART FILE (LU).....	0
INPUT GEOMETRY FILE (LU).....	11
OUTPUT GEOMETRY FILE (LU).....	0
STREAM/PATHLINE DATA FILE (LU).....	13
TEMPERATURE INPUT FILE (TEMPERATURE INACTIVE).....	0
INITIAL CONDITION OUTPUT FILE (FORMATTED).....	0
SCALE FACTOR FOR X COORDINATES.....	1.00
SCALE FACTOR FOR Y COORDINATES.....	1.00
LEFT BOUNDARY FOR QUAD ELEMENTS.....	0.00
RIGHT BOUNDARY FOR QUAD ELEMENTS.....	0.00
TOP BOUNDARY FOR QUAD ELEMENTS.....	0.00
BOTTOM BOUNDARY FOR QUAD ELEMENTS.....	0.00
START TIME (YEARS).....	0.00
WEIGHTING FACTOR.....	1.5
DENSITY/VISCOSITY REFERENCE TEMP (>0.05 TO IMPLEMENT).....	50.0

TIME CONTROL AND RUN SPECIFICATIONS

NUMBER OF TIME STEPS	PRINT INTERVAL	TIME STEP	TIME(YEARS)
5	5	0.2000	1.000
4	4	1.000	5.000
2	2	2.500	10.00

LISTING D-6. Output Report File for Test Case Two. (Sheet 3 of 48)

TABLE 2. - NODE POINT COORDINATES

NODE	XCORD	YCORD	NODE	XCORD	YCORD	NODE	XCORD	YCORD	NODE	XCORD	YCORD
1	0.00	-2.50	51	1.00	-1.50	101	1.00	-0.64	151	0.50	-0.19
2	0.12	-2.50	52	0.81	-1.50	102	0.81	-0.65	152	1.00	-0.27
3	0.20	-2.50	53	1.89	-1.75	103	1.89	-0.81	153	1.00	-0.19
4	0.28	-2.50	54	1.89	-1.50	104	1.89	-0.64	154	0.81	-0.19
5	0.38	-2.50	55	1.39	-1.50	105	1.39	-0.64	155	1.89	-0.28
6	0.50	-2.50	56	3.22	-1.75	106	3.22	-0.81	156	1.89	-0.20
7	0.64	-2.50	57	3.22	-1.50	107	3.22	-0.64	157	1.39	-0.20
8	0.81	-2.50	58	2.50	-1.50	108	2.50	-0.64	158	3.22	-0.28
9	1.00	-2.50	59	5.00	-1.75	109	5.00	-0.81	159	3.22	-0.20
10	1.39	-2.50	60	5.00	-1.50	110	5.00	-0.64	160	2.50	-0.20
11	1.89	-2.50	61	4.06	-1.50	111	4.06	-0.64	161	5.00	-0.28
12	2.50	-2.50	62	0.20	-1.25	112	0.00	-0.42	162	5.00	-0.20
13	3.22	-2.50	63	0.19	-1.00	113	0.00	-0.53	163	4.06	-0.20
14	4.06	-2.50	64	0.12	-1.00	114	0.11	-0.52	164	0.00	-0.22
15	5.00	-2.50	65	0.00	-1.00	115	0.11	-0.41	165	0.00	-0.24
16	0.20	-2.25	66	0.00	-1.25	116	0.06	-0.42	166	0.10	-0.23
17	0.20	-2.00	67	0.38	-1.25	117	0.19	-0.50	167	0.10	-0.21
18	0.12	-2.00	68	0.38	-1.00	118	0.19	-0.37	168	0.05	-0.22
19	0.00	-2.00	69	0.27	-1.00	119	0.15	-0.39	169	0.18	-0.18
20	0.00	-2.25	70	0.64	-1.25	120	0.38	-0.50	170	0.17	-0.17
21	0.38	-2.25	71	0.64	-1.00	121	0.38	-0.38	171	0.13	-0.20
22	0.38	-2.00	72	0.50	-1.00	122	0.27	-0.37	172	0.24	-0.10
23	0.28	-2.00	73	1.00	-1.25	123	0.65	-0.50	173	0.22	-0.14
24	0.64	-2.25	74	1.00	-1.00	124	0.65	-0.38	174	0.39	-0.15
25	0.64	-2.00	75	0.81	-1.00	125	0.50	-0.38	175	0.41	-0.11
26	0.50	-2.00	76	1.89	-1.25	126	1.00	-0.50	176	0.31	-0.10
27	1.00	-2.25	77	1.69	-1.00	127	1.00	-0.38	177	0.21	-0.10
28	1.00	-2.00	78	1.39	-1.00	128	0.81	-0.38	178	0.20	-0.13
29	0.81	-2.00	79	3.22	-1.25	129	1.89	-0.50	179	0.23	-0.10
30	1.89	-2.25	80	3.22	-1.00	130	1.89	-0.38	180	0.66	-0.16
31	1.89	-2.00	81	2.50	-1.00	131	1.39	-0.38	181	0.66	-0.11
32	1.39	-2.00	82	5.00	-1.25	132	3.22	-0.50	182	0.52	-0.11
33	3.22	-2.25	83	5.00	-1.00	133	3.22	-0.38	183	0.83	-0.15
34	3.22	-2.00	84	4.06	-1.00	134	2.50	-0.38	184	1.00	0.00
35	2.50	-2.00	85	0.15	-0.83	135	5.00	-0.50	185	0.83	-0.06
36	5.00	-2.25	86	0.11	-0.66	136	5.00	-0.38	186	1.00	-0.12
37	5.00	-2.00	87	0.06	-0.83	137	4.06	-0.38	187	1.89	-0.12
38	4.06	-2.00	88	0.19	-0.81	138	0.00	-0.25	188	1.89	0.00
39	0.20	-1.75	89	0.19	-0.65	139	0.00	-0.32	189	1.39	0.00
40	0.20	-1.50	90	0.16	-0.66	140	0.10	-0.31	190	3.22	-0.12
41	0.12	-1.50	91	0.38	-0.81	141	0.10	-0.24	191	3.22	0.00
42	0.00	-1.50	92	0.38	-0.65	142	0.05	-0.25	192	2.50	0.00
43	0.00	-1.75	93	0.27	-0.65	143	0.19	-0.27	193	5.00	-0.12
44	0.38	-1.75	94	0.06	-0.67	144	0.19	-0.19	194	5.00	0.00
45	0.38	-1.50	95	0.00	-0.67	145	0.14	-0.22	195	4.06	0.00
46	0.28	-1.50	96	0.00	-0.82	146	0.37	-0.27	196	0.00	-0.20
47	0.64	-1.75	97	0.65	-0.81	147	0.37	-0.19	197	0.00	-0.21
48	0.64	-1.50	98	0.65	-0.65	148	0.27	-0.19	198	0.09	-0.20
49	0.50	-1.50	99	0.50	-0.65	149	0.65	-0.27	199	0.09	-0.19
50	1.00	-1.75	100	1.00	-0.81	150	0.65	-0.19	200	0.05	-0.20

LISTING D-6. Output Report File for Test Case Two. (Sheet 4 of 48)

TABLE 2. - NODE POINT COORDINATES

NODE	XCORD	YCORD	NODE	XCORD	YCORD	NODE	XCORD	YCORD	NODE	XCORD	YCORD
201	0.16	-0.16	251	0.23	0.10	301	0.00	0.15	351	0.50	1.00
202	0.15	-0.15	252	0.21	0.10	302	0.50	0.38	352	0.38	1.00
203	0.12	-0.17	253	0.22	0.05	303	0.38	0.38	353	0.38	0.81
204	0.19	-0.09	254	0.52	0.11	304	0.37	0.27	354	3.22	0.81
205	0.17	-0.12	255	0.20	0.09	305	0.27	0.37	355	3.22	1.00
206	0.20	-0.09	256	0.19	0.09	306	0.19	0.37	356	2.50	1.00
207	0.25	0.00	257	0.20	0.05	307	0.19	0.27	357	0.27	1.00
208	0.25	-0.05	258	0.15	0.10	308	1.00	0.50	358	0.19	1.00
209	0.42	-0.06	259	0.10	0.10	309	1.00	0.64	359	0.19	0.81
210	0.42	0.00	260	0.10	0.05	310	0.81	0.65	360	5.00	0.81
211	0.32	0.00	261	0.81	0.19	311	0.45	0.45	361	5.00	1.00
212	0.22	0.00	262	0.65	0.19	312	0.65	0.50	362	4.06	1.00
213	0.22	-0.05	263	0.64	0.16	313	1.89	0.50	363	0.00	0.25
214	0.24	0.00	264	0.50	0.19	314	1.89	0.64	364	0.05	0.25
215	0.67	-0.04	265	0.37	0.19	315	1.39	0.64	365	0.06	0.42
216	0.67	0.00	266	0.39	0.15	316	0.50	0.45	366	0.00	0.42
217	0.53	0.00	267	1.00	0.27	317	0.38	0.65	367	0.00	0.32
218	0.20	0.00	268	1.00	0.38	318	0.38	0.50	368	0.00	0.24
219	0.20	-0.05	269	0.81	0.38	319	3.22	0.50	369	0.06	0.67
220	0.21	0.00	270	0.65	0.38	320	3.22	0.64	370	0.00	0.67
221	0.62	0.00	271	0.65	0.27	321	2.50	0.64	371	0.00	0.53
222	0.83	0.06	272	1.89	0.28	322	5.00	0.50	372	0.15	0.83
223	0.66	0.11	273	1.89	0.38	323	5.00	0.64	373	0.00	1.00
224	0.67	0.06	274	1.39	0.38	324	4.06	0.64	374	0.06	0.83
225	1.00	0.12	275	3.22	0.28	325	0.10	0.24	375	0.12	1.00
226	1.00	0.19	276	3.22	0.38	326	0.14	0.22	376	0.00	0.82
227	0.83	0.15	277	2.50	0.38	327	0.15	0.39	377	1.00	1.25
228	1.89	0.12	278	5.00	0.28	328	0.11	0.41	378	1.00	1.50
229	1.89	0.20	279	5.00	0.38	329	0.10	0.31	379	0.81	1.50
230	1.39	0.20	280	4.06	0.38	330	0.10	0.21	380	0.64	1.50
231	3.22	0.12	281	0.00	0.00	331	0.13	0.20	381	0.64	1.25
232	3.22	0.20	282	0.00	-0.05	332	0.10	0.23	382	1.89	1.25
233	2.50	0.20	283	0.05	0.00	333	0.09	0.20	383	1.89	1.50
234	5.00	0.12	284	0.05	0.10	334	0.05	0.22	384	1.39	1.50
235	5.00	0.20	285	0.00	0.10	335	0.00	0.22	385	0.50	1.50
236	4.06	0.20	286	0.00	0.05	336	0.00	0.21	386	0.38	1.50
237	0.00	-0.10	287	0.27	0.19	337	0.27	0.65	387	0.38	1.25
238	0.00	-0.15	288	0.19	0.19	338	0.19	0.65	388	3.22	1.25
239	0.10	-0.15	289	0.22	0.14	339	0.19	0.50	389	3.22	1.50
240	0.10	-0.10	290	0.18	0.18	340	0.16	0.66	390	2.50	1.50
241	0.05	-0.10	291	0.17	0.17	341	0.11	0.66	391	0.28	1.50
242	0.15	-0.10	292	0.20	0.13	342	0.11	0.52	392	0.20	1.50
243	0.10	0.00	293	0.16	0.16	343	1.00	0.81	393	0.20	1.25
244	0.10	-0.05	294	0.15	0.15	344	1.00	1.00	394	5.00	1.25
245	0.15	0.00	295	0.17	0.12	345	0.81	1.00	395	5.00	1.50
246	0.42	0.06	296	0.12	0.17	346	0.64	1.00	396	4.06	1.50
247	0.41	0.11	297	0.09	0.19	347	0.65	0.81	397	0.00	1.50
248	0.31	0.10	298	0.10	0.15	348	1.89	0.81	398	0.00	1.25
249	0.24	0.10	299	0.05	0.20	349	1.89	1.00	399	0.12	1.50
250	0.25	0.05	300	0.00	0.20	350	1.39	1.00	400	1.00	1.75

2 2 1 2 4 1 3 1 4 9 7

LISTING D-6. Output Report File for Test Case Two. (Sheet 5 of 48)

TABLE 2. - NODE POINT COORDINATES

NODE	XCORD	YCORD	NODE	XCORD	YCORD	NODE	XCORD	YCORD	NODE	XCORD	YCORD
401	1.00	2.00	413	2.50	2.00	425	0.81	2.50	437	0.28	2.50
402	0.81	2.00	414	0.28	2.00	426	0.64	2.50	438	0.20	2.50
403	0.64	2.00	415	0.20	2.00	427	0.44	2.25	439	0.20	2.25
404	0.64	1.75	416	0.20	1.75	428	1.89	2.25	440	5.00	2.25
405	1.89	1.75	417	5.00	1.75	429	1.89	2.50	441	5.00	2.50
406	1.89	2.00	418	5.00	2.00	430	1.39	2.50	442	4.06	2.50
407	1.39	2.00	419	4.06	2.00	431	0.50	2.50	443	0.00	2.50
408	0.50	2.00	420	0.00	2.00	432	0.38	2.50	444	0.00	2.25
409	0.38	2.00	421	0.00	1.75	433	0.38	2.25	445	0.12	2.50
410	0.38	1.75	422	0.12	2.00	434	3.22	2.25			
411	3.22	1.75	423	1.00	2.25	435	3.22	2.50			
412	3.22	2.00	424	1.00	2.50	436	2.50	2.50			

LISTING D-6. Output Report File for Test Case Two. (Sheet 6 of 48)

TABLE 3. ~ ELEMENT/NODE CONNECTIVITY

ELEMENT	CONNECTIONS								TYPE	ORDER	ELEMENT	CONNECTIONS								TYPE	ORDER
	M	N1	N2	N3	N4	N5	N6	N7				M	N1	N2	N3	N4	N5	N6	N7	N8	
1	1	2	3	16	17	18	19	20	3	1	51	175	174	147	151	150	180	181	182	3	51
2	17	16	3	4	5	21	22	23	3	2	52	153	183	181	180	150	154	0	0	3	52
3	22	21	5	6	7	24	25	26	3	3	53	184	185	181	183	153	186	0	0	3	53
4	25	24	7	8	9	27	28	29	3	4	54	184	186	153	157	156	187	188	189	3	54
5	28	27	9	10	11	30	31	32	3	5	55	188	187	156	160	159	190	191	192	3	55
6	31	30	11	12	13	33	34	35	3	6	56	191	190	159	163	162	193	194	195	3	56
7	34	33	13	14	15	36	37	38	3	7	57	196	197	164	168	167	198	199	200	3	57
8	19	18	17	39	40	41	42	43	3	8	58	199	198	167	171	170	201	202	203	3	58
9	40	39	17	23	22	44	45	46	3	9	59	204	205	202	201	170	178	177	206	3	59
10	45	44	22	26	25	47	48	49	3	10	60	207	208	172	176	175	209	210	211	3	60
11	48	47	25	29	28	50	51	52	3	11	61	212	213	177	179	172	208	207	214	3	61
12	51	50	28	32	31	53	54	55	3	12	62	210	209	175	182	181	215	216	217	3	62
13	54	53	31	35	34	56	57	58	3	13	63	218	219	204	206	177	213	212	220	3	63
14	57	56	34	38	37	59	60	61	3	14	64	216	215	181	185	184	221	0	0	3	64
15	42	41	40	62	63	64	65	66	3	15	65	216	221	184	222	223	224	0	0	3	65
16	63	62	40	46	45	67	68	69	3	16	66	184	225	226	227	223	222	0	0	3	66
17	68	67	45	49	48	70	71	72	3	17	67	184	189	188	228	229	230	226	225	3	67
18	71	70	48	52	51	73	74	75	3	18	68	188	192	191	231	232	233	229	228	3	68
19	74	73	51	55	54	76	77	78	3	19	69	191	195	194	234	235	236	232	231	3	69
20	77	76	54	58	57	79	80	81	3	20	70	237	238	196	200	199	239	240	241	1	70
21	80	79	57	61	60	82	83	84	3	21	71	240	239	199	203	202	205	204	242	1	71
22	65	64	63	85	86	87	0	0	3	22	72	243	244	240	242	204	219	218	245	1	72
23	86	85	63	88	89	90	0	0	3	23	73	207	211	210	246	247	248	249	250	3	73
24	89	88	63	69	68	91	92	93	3	24	74	212	214	207	250	249	251	252	253	2	74
25	65	87	86	94	95	96	0	0	3	25	75	210	217	216	224	223	254	247	246	2	75
26	92	91	68	72	71	97	98	99	3	26	76	218	220	212	253	252	255	256	257	2	76
27	98	97	71	75	74	100	101	102	3	27	77	243	245	218	257	256	258	259	260	1	77
28	101	100	74	78	77	103	104	105	3	28	78	226	261	262	263	223	227	0	0	3	78
29	104	103	77	81	80	106	107	108	3	29	79	247	254	223	263	262	264	265	266	3	79
30	107	106	80	84	83	109	110	111	3	30	80	262	261	226	267	268	269	270	271	3	80
31	112	113	95	94	86	114	115	116	3	31	81	226	230	229	272	273	274	268	267	3	81
32	115	114	86	90	89	117	118	119	3	32	82	229	233	232	275	276	277	273	272	3	82
33	118	117	89	93	92	120	121	122	3	33	83	232	234	235	278	279	280	276	275	3	83
34	121	120	92	99	98	123	124	125	3	34	84	281	282	237	241	240	244	243	283	1	84
35	124	123	98	102	101	126	127	128	3	35	85	281	283	243	260	259	284	285	286	1	85
36	127	126	101	105	104	129	130	131	3	36	86	249	248	247	266	265	287	288	289	3	86
37	130	129	104	108	107	132	133	134	3	37	87	252	251	249	289	288	290	291	292	3	87
38	133	132	107	111	110	135	136	137	3	38	88	256	255	252	292	291	293	294	295	3	88
39	138	139	112	116	115	140	141	142	3	39	89	259	258	256	295	294	296	297	298	1	89
40	141	140	115	119	118	143	144	145	3	40	90	285	284	259	298	297	299	300	301	1	90
41	144	143	118	122	121	146	147	148	3	41	91	265	264	262	271	270	302	303	304	3	91
42	147	146	121	125	124	149	150	151	3	42	92	288	287	265	304	303	305	306	307	3	92
43	150	149	124	128	127	152	153	154	3	43	93	270	269	268	308	309	310	311	312	3	93
44	153	152	127	131	130	155	156	157	3	44	94	268	274	273	313	314	315	309	308	3	94
45	156	155	130	134	133	158	159	160	3	45	95	303	302	270	312	311	314	317	318	3	95
46	159	158	133	137	136	161	162	163	3	46	96	273	277	276	319	320	321	314	313	3	96
47	164	165	138	142	141	166	167	168	2	47	97	276	280	279	322	323	324	320	319	3	97
48	167	166	141	145	144	169	170	171	2	48	98	325	326	288	307	306	327	328	329	3	98
49	172	173	144	148	147	174	175	176	3	49	99	330	331	291	290	288	326	325	332	2	99
50	177	178	170	169	144	173	172	179	2	50	100	297	296	294	293	291	331	330	333	2	100

LISTING D-6. Output Report File for Test Case Two. (Sheet 7 of 48)

TABLE 3. - ELEMENT/NODE CONNECTIVITY

ELEMENT	CONNECTIONS								TYPE	ORDER	ELEMENT	CONNECTIONS								TYPE	ORDER	
	M	N1	N2	N3	N4	N5	N6	N7				M	N1	N2	N3	N4	N5	N6	N7	N8		
101	300	277	277	333	330	334	335	336	2	101		119	349	356	355	388	389	390	383	382	3	119
102	306	305	303	318	317	337	338	339	3	102		120	358	357	352	387	388	391	392	393	3	120
103	328	327	304	339	338	340	341	342	3	103		121	355	362	361	394	395	396	389	388	3	121
104	311	310	309	343	344	345	346	347	3	104		122	397	398	373	375	358	393	392	399	3	122
105	309	315	314	348	349	350	344	343	3	105		123	380	379	378	400	401	402	403	404	3	123
106	317	316	311	347	346	351	352	353	3	106		124	378	384	383	405	406	407	401	400	3	124
107	314	321	320	354	355	356	349	348	3	107		125	386	385	380	404	403	408	409	410	3	125
108	338	337	317	353	352	357	358	359	3	108		126	383	390	389	411	412	413	406	405	3	126
109	320	324	323	360	361	362	355	354	3	109		127	392	391	386	410	409	414	415	416	3	127
110	363	364	325	329	328	365	366	367	3	110		128	389	396	395	417	418	419	412	411	3	128
111	355	334	330	332	325	364	363	368	2	111		129	420	421	397	399	392	416	415	422	3	129
112	366	365	328	342	341	369	370	371	3	112		130	403	402	401	423	424	425	426	427	3	130
113	341	340	338	359	358	372	0	0	3	113		131	401	407	406	428	429	430	424	423	3	131
114	373	374	341	372	358	375	0	0	3	114		132	409	408	403	427	426	431	432	433	3	132
115	373	376	370	349	341	374	0	0	3	115		133	406	413	412	434	435	436	429	428	3	133
116	346	345	344	377	378	379	380	381	3	116		134	415	414	409	433	432	437	438	439	3	134
117	344	350	349	382	383	384	378	377	3	117		135	412	419	418	440	441	442	435	434	3	135
118	352	351	346	381	380	385	386	387	3	118		136	443	444	420	422	415	439	438	445	3	136

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LISTING D-6. Output Report File for Test Case Two. (Sheet 8 of 48)

TABLE 4. - INITIAL CONDITIONS

NODE	T(C)	H(M)	NODE	T(C)	H(M)	NODE	T(C)	H(M)
1	50.00	1.20	51	50.00	1.16	101	50.00	1.12
2	50.00	1.20	52	50.00	1.16	102	50.00	1.12
3	50.00	1.20	53	50.00	1.17	103	50.00	1.13
4	50.00	1.20	54	50.00	1.16	104	50.00	1.13
5	50.00	1.20	55	50.00	1.16	105	50.00	1.13
6	50.00	1.20	56	50.00	1.17	106	50.00	1.13
7	50.00	1.20	57	50.00	1.16	107	50.00	1.13
8	50.00	1.20	58	50.00	1.16	108	50.00	1.13
9	50.00	1.20	59	50.00	1.17	109	50.00	1.13
10	50.00	1.20	60	50.00	1.16	110	50.00	1.13
11	50.00	1.20	61	50.00	1.16	111	50.00	1.13
12	50.00	1.20	62	50.00	1.15	112	50.00	1.11
13	50.00	1.20	63	50.00	1.14	113	50.00	1.11
14	50.00	1.20	64	50.00	1.14	114	50.00	1.11
15	50.00	1.20	65	50.00	1.14	115	50.00	1.11
16	50.00	1.19	66	50.00	1.15	116	50.00	1.11
17	50.00	1.18	67	50.00	1.15	117	50.00	1.11
18	50.00	1.18	68	50.00	1.14	118	50.00	1.11
19	50.00	1.18	69	50.00	1.14	119	50.00	1.11
20	50.00	1.19	70	50.00	1.15	120	50.00	1.12
21	50.00	1.19	71	50.00	1.14	121	50.00	1.11
22	50.00	1.18	72	50.00	1.14	122	50.00	1.11
23	50.00	1.18	73	50.00	1.15	123	50.00	1.12
24	50.00	1.19	74	50.00	1.14	124	50.00	1.11
25	50.00	1.18	75	50.00	1.14	125	50.00	1.11
26	50.00	1.18	76	50.00	1.15	126	50.00	1.12
27	50.00	1.19	77	50.00	1.14	127	50.00	1.11
28	50.00	1.18	78	50.00	1.14	128	50.00	1.11
29	50.00	1.18	79	50.00	1.15	129	50.00	1.12
30	50.00	1.19	80	50.00	1.14	130	50.00	1.11
31	50.00	1.18	81	50.00	1.14	131	50.00	1.11
32	50.00	1.18	82	50.00	1.15	132	50.00	1.12
33	50.00	1.19	83	50.00	1.14	133	50.00	1.11
34	50.00	1.18	84	50.00	1.14	134	50.00	1.11
35	50.00	1.18	85	50.00	1.13	135	50.00	1.12
36	50.00	1.19	86	50.00	1.12	136	50.00	1.11
37	50.00	1.18	87	50.00	1.13	137	50.00	1.11
38	50.00	1.18	88	50.00	1.13	138	50.00	1.10
39	50.00	1.17	89	50.00	1.12	139	50.00	1.10
40	50.00	1.16	90	50.00	1.12	140	50.00	1.10
41	50.00	1.16	91	50.00	1.13	141	50.00	1.10
42	50.00	1.16	92	50.00	1.12	142	50.00	1.10
43	50.00	1.17	93	50.00	1.12	143	50.00	1.10
44	50.00	1.17	94	50.00	1.12	144	50.00	1.10
45	50.00	1.16	95	50.00	1.12	145	50.00	1.10
46	50.00	1.16	96	50.00	1.13	146	50.00	1.11
47	50.00	1.17	97	50.00	1.13	147	50.00	1.10
48	50.00	1.16	98	50.00	1.12	148	50.00	1.10
49	50.00	1.16	99	50.00	1.12	149	50.00	1.11
50	50.00	1.17	100	50.00	1.13	150	50.00	1.11

2 3 1 2 4 1 3 1 5 0 1

LISTING D-6. Output Report File for Test Case Two. (Sheet 9 of 48)

TABLE 4. - INITIAL CONDITIONS

NODE	T(C)	H(M)	NODE	T(C)	H(M)	NODE	T(C)	H(M)
151	50.00	1.10	201	50.00	1.10	251	50.00	1.10
152	50.00	1.11	202	50.00	1.10	252	50.00	1.10
153	50.00	1.11	203	50.00	1.10	253	50.00	1.10
154	50.00	1.11	204	50.00	1.10	254	50.00	1.10
155	50.00	1.11	205	50.00	1.10	255	50.00	1.10
156	50.00	1.11	206	50.00	1.10	256	50.00	1.10
157	50.00	1.11	207	50.00	1.10	257	50.00	1.10
158	50.00	1.11	208	50.00	1.10	258	50.00	1.10
159	50.00	1.11	209	50.00	1.10	259	50.00	1.10
160	50.00	1.11	210	50.00	1.10	260	50.00	1.10
161	50.00	1.11	211	50.00	1.10	261	50.00	1.09
162	50.00	1.11	212	50.00	1.10	262	50.00	1.09
163	50.00	1.11	213	50.00	1.10	263	50.00	1.09
164	50.00	1.10	214	50.00	1.10	264	50.00	1.09
165	50.00	1.10	215	50.00	1.10	265	50.00	1.10
166	50.00	1.10	216	50.00	1.10	266	50.00	1.10
167	50.00	1.10	217	50.00	1.10	267	50.00	1.09
168	50.00	1.10	218	50.00	1.10	268	50.00	1.09
169	50.00	1.10	219	50.00	1.10	269	50.00	1.09
170	50.00	1.10	220	50.00	1.10	270	50.00	1.09
171	50.00	1.10	221	50.00	1.10	271	50.00	1.09
172	50.00	1.10	222	50.00	1.10	272	50.00	1.09
173	50.00	1.10	223	50.00	1.10	273	50.00	1.08
174	50.00	1.10	224	50.00	1.10	274	50.00	1.08
175	50.00	1.10	225	50.00	1.09	275	50.00	1.09
176	50.00	1.10	226	50.00	1.09	276	50.00	1.08
177	50.00	1.10	227	50.00	1.09	277	50.00	1.08
178	50.00	1.10	228	50.00	1.09	278	50.00	1.09
179	50.00	1.10	229	50.00	1.09	279	50.00	1.08
180	50.00	1.10	230	50.00	1.09	280	50.00	1.08
181	50.00	1.10	231	50.00	1.09	281	50.00	1.10
182	50.00	1.10	232	50.00	1.09	282	50.00	1.10
183	50.00	1.10	233	50.00	1.09	283	50.00	1.10
184	50.00	1.10	234	50.00	1.09	284	50.00	1.10
185	50.00	1.10	235	50.00	1.09	285	50.00	1.10
186	50.00	1.10	236	50.00	1.09	286	50.00	1.10
187	50.00	1.10	237	50.00	1.10	287	50.00	1.10
188	50.00	1.10	238	50.00	1.10	288	50.00	1.10
189	50.00	1.10	239	50.00	1.10	289	50.00	1.10
190	50.00	1.10	240	50.00	1.10	290	50.00	1.10
191	50.00	1.10	241	50.00	1.10	291	50.00	1.10
192	50.00	1.10	242	50.00	1.10	292	50.00	1.10
193	50.00	1.10	243	50.00	1.10	293	50.00	1.10
194	50.00	1.10	244	50.00	1.10	294	50.00	1.10
195	50.00	1.10	245	50.00	1.10	295	50.00	1.10
196	50.00	1.10	246	50.00	1.10	296	50.00	1.10
197	50.00	1.10	247	50.00	1.10	297	50.00	1.10
198	50.00	1.10	248	50.00	1.10	298	50.00	1.10
199	50.00	1.10	249	50.00	1.10	299	50.00	1.10
200	50.00	1.10	250	50.00	1.10	300	50.00	1.10

2 2 1 2 4 1 3 1 5 0 2

LISTING D-6. Output Report File for Test Case Two. (Sheet 10 of 48)

TABLE 4. - INITIAL CONDITIONS

NODE	T(C)	H(M)	NODE	T(C)	H(M)	NODE	T(C)	H(M)
301	50.00	1.10	350	50.00	1.06	399	50.00	1.04
302	50.00	1.09	351	50.00	1.06	400	50.00	1.03
303	50.00	1.09	352	50.00	1.06	401	50.00	1.02
304	50.00	1.09	353	50.00	1.07	402	50.00	1.02
305	50.00	1.09	354	50.00	1.07	403	50.00	1.02
306	50.00	1.09	355	50.00	1.06	404	50.00	1.03
307	50.00	1.10	356	50.00	1.06	405	50.00	1.03
308	50.00	1.08	357	50.00	1.06	406	50.00	1.02
309	50.00	1.08	358	50.00	1.06	407	50.00	1.02
310	50.00	1.08	359	50.00	1.07	408	50.00	1.02
311	50.00	1.08	360	50.00	1.07	409	50.00	1.02
312	50.00	1.08	361	50.00	1.06	410	50.00	1.03
313	50.00	1.08	362	50.00	1.06	411	50.00	1.03
314	50.00	1.07	363	50.00	1.10	412	50.00	1.02
315	50.00	1.07	364	50.00	1.10	413	50.00	1.02
316	50.00	1.08	365	50.00	1.09	414	50.00	1.02
317	50.00	1.08	366	50.00	1.09	415	50.00	1.02
318	50.00	1.08	367	50.00	1.10	416	50.00	1.03
319	50.00	1.08	368	50.00	1.10	417	50.00	1.03
320	50.00	1.07	369	50.00	1.08	418	50.00	1.02
321	50.00	1.07	370	50.00	1.08	419	50.00	1.02
322	50.00	1.08	371	50.00	1.08	420	50.00	1.02
323	50.00	1.07	372	50.00	1.07	421	50.00	1.03
324	50.00	1.07	373	50.00	1.06	422	50.00	1.02
325	50.00	1.10	374	50.00	1.07	423	50.00	1.01
326	50.00	1.10	375	50.00	1.06	424	50.00	1.00
327	50.00	1.09	376	50.00	1.07	425	50.00	1.00
328	50.00	1.09	377	50.00	1.05	426	50.00	1.00
329	50.00	1.10	378	50.00	1.04	427	50.00	1.01
330	50.00	1.10	379	50.00	1.04	428	50.00	1.01
331	50.00	1.10	380	50.00	1.04	429	50.00	1.00
332	50.00	1.10	381	50.00	1.05	430	50.00	1.00
333	50.00	1.10	382	50.00	1.05	431	50.00	1.00
334	50.00	1.10	383	50.00	1.04	432	50.00	1.00
335	50.00	1.10	384	50.00	1.04	433	50.00	1.01
336	50.00	1.10	385	50.00	1.04	434	50.00	1.01
337	50.00	1.08	386	50.00	1.04	435	50.00	1.00
338	50.00	1.08	387	50.00	1.05	436	50.00	1.00
339	50.00	1.09	388	50.00	1.05	437	50.00	1.00
340	50.00	1.08	389	50.00	1.04	438	50.00	1.00
341	50.00	1.08	390	50.00	1.04	439	50.00	1.01
342	50.00	1.08	391	50.00	1.04	440	50.00	1.01
343	50.00	1.07	392	50.00	1.04	441	50.00	1.00
344	50.00	1.06	393	50.00	1.05	442	50.00	1.00
345	50.00	1.06	394	50.00	1.05	443	50.00	1.00
346	50.00	1.06	395	50.00	1.04	444	50.00	1.01
347	50.00	1.07	396	50.00	1.04	445	50.00	1.00
348	50.00	1.07	397	50.00	1.04			
349	50.00	1.06	398	50.00	1.05			

LISTING D-6. Output Report File for Test Case Two. (Sheet 11 of 48)

TABLE 5. - SPECIFIED BOUNDARY CONDITIONS

NUMBER OF SPECIFIED BOUNDARY NODES 30

NODE	TYPE	T(C)	H(M)
1	(11)	50.000	1.200
2	(11)	50.000	1.200
3	(11)	50.000	1.200
4	(11)	50.000	1.200
5	(11)	50.000	1.200
6	(11)	50.000	1.200
7	(11)	50.000	1.200
8	(11)	50.000	1.200
9	(11)	50.000	1.200
10	(11)	50.000	1.200
11	(11)	50.000	1.200
12	(11)	50.000	1.200
13	(11)	50.000	1.200
14	(11)	50.000	1.200
15	(11)	50.000	1.200
441	(11)	50.000	1.000
442	(11)	50.000	1.000
435	(11)	50.000	1.000
436	(11)	50.000	1.000
429	(11)	50.000	1.000
430	(11)	50.000	1.000
424	(11)	50.000	1.000
425	(11)	50.000	1.000
426	(11)	50.000	1.000
431	(11)	50.000	1.000
432	(11)	50.000	1.000
437	(11)	50.000	1.000
438	(11)	50.000	1.000
445	(11)	50.000	1.000
443	(11)	50.000	1.000

LISTING D-6. Output Report File for Test Case Two. (Sheet 12 of 48)

TABLE 6. - ROCK PROPERTIES

PARAMETER	ROCK TYPES		
	1 CANST	2 PCKNG	3 STRESS
1. SPECIFIC HEAT (J/KG-C)	1.500E+03	9.300E+02	9.300E+02
2. THERMAL CONDUCTIVITY IN X (J/SEC-M-C)	1.500E+00	8.000E-01	1.000E+00
3. THERMAL CONDUCTIVITY IN Y (J/SEC-M-C)	1.500E+00	8.000E-01	1.000E+00
4. EFFECTIVE POROSITY (FRACTION)	1.000E-02	3.000E-01	2.200E-04
5. HYDRAULIC CONDUCTIVITY (KXX-M/SEC)	1.000E-08	1.000E-09	1.000E-12
6. HYDRAULIC CONDUCTIVITY (KZZ-M/SEC)	1.000E-08	1.000E-09	1.000E-12
7. SPECIFIC STORAGE (1/M)	1.000E-03	1.000E-03	1.000E-05
8. ROCK DENSITY (KG/M**3)	2.500E+03	1.800E+03	2.780E+03
9. LONGITUDINAL DISPERSIVITY (M)	1.000E-10	1.000E-10	1.000E-10
10. LATERAL DISPERSIVITY (M)	1.000E-10	1.000E-10	1.000E-10
11. FRACTURE/FAULT THICKNESS (M)	0.000E-01	0.000E-01	0.000E-01

TABLE 7. - HEAT GENERATION HISTORY

NUMBER OF HEAT SOURCE ELEMENTS..... 8
 NUMBER OF TIME POINTS..... 2
 SCALE FACTOR FOR HEAT LOAD..... 1.00

HEAT SOURCE ELEMENT NUMBER
 70 71 72 77 84 85 89 90

TIME (YR)	THERMAL LOAD (J/YR-M**3)
0.000	0.100E+11
0.100E+04	0.100E+11

LISTING D-6. Output Report File for Test Case Two. (Sheet 13 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

RESULTS ON YEAR 1.000

NODE	T(C)	H(M)	NODE	T(C)	H(M)	NODE	T(C)	H(M)
1	50.00	*	1.200	*		51	53.62	1.358
2	50.00	*	1.200	*		52	53.90	1.371
3	50.00	*	1.200	*		53	51.77	1.272
4	50.00	*	1.200	*		54	52.33	1.293
5	50.00	*	1.200	*		55	53.03	1.329
6	50.00	*	1.200	*		56	50.86	1.221
7	50.00	*	1.200	*		57	51.12	1.227
8	50.00	*	1.200	*		58	51.65	1.257
9	50.00	*	1.200	*		59	50.50	1.200
10	50.00	*	1.200	*		60	50.65	1.198
11	50.00	*	1.200	*		61	50.77	1.206
12	50.00	*	1.200	*		62	55.91	1.456
13	50.00	*	1.200	*		63	57.52	1.521
14	50.00	*	1.200	*		64	57.59	1.524
15	50.00	*	1.200	*		65	57.63	1.526
16	51.06	1.248		66	55.98	1.459	116	63.73
17	52.15	1.297		67	55.73	1.448	117	62.07
18	52.16	1.298		68	57.22	1.508	118	63.74
19	52.17	1.298		69	57.40	1.516	119	63.68
20	51.07	1.249		70	55.30	1.429	120	61.04
21	51.04	1.247		71	56.56	1.480	121	62.17
22	52.10	1.295		72	56.94	1.496	122	63.10
23	52.13	1.297		73	54.58	1.396	123	59.29
24	50.99	1.244		74	55.53	1.434	124	59.91
25	51.99	1.290		75	56.08	1.459	125	61.09
26	52.06	1.293		76	52.85	1.313	126	57.28
27	50.89	1.239		77	53.32	1.329	127	57.61
28	51.78	1.279		78	54.47	1.384	128	58.74
29	51.90	1.285		79	51.35	1.231	129	54.04
30	50.60	1.225		80	51.55	1.233	130	54.15
31	51.19	1.249		81	52.32	1.276	131	55.79
32	51.52	1.266		82	50.78	1.196	132	51.83
33	50.29	1.208		83	50.89	1.193	133	51.87
34	50.58	1.215		84	51.04	1.204	134	52.83
35	50.86	1.231		85	58.85	1.572	135	51.05
36	50.17	1.200		86	60.46	1.634	136	51.07
37	50.34	1.200		87	58.95	1.576	137	51.28
38	50.40	1.204		88	58.94	1.576	138	67.25
39	53.29	1.347		89	60.46	1.633	139	65.53
40	54.53	1.400		90	60.45	1.633	140	65.39
41	54.56	1.401		91	58.50	1.558	141	67.06
42	54.58	1.402		92	59.78	1.607	142	67.14
43	53.32	1.348		93	60.20	1.623	143	65.43
44	53.22	1.343		94	60.50	1.635	144	66.96
45	54.41	1.395		95	60.53	1.636	145	67.00
46	54.49	1.398		96	59.04	1.580	146	63.13
47	53.03	1.335		97	57.57	1.519	147	63.79
48	54.13	1.381		98	58.49	1.554	148	65.45
49	54.29	1.389		99	59.21	1.583	149	60.35
50	52.69	1.318	100	56.24	1.461		150	60.63

LISTING D-6. Output Report File for Test Case Two. (Sheet 14 of 48)

SAMPLE PROBLEM. FLOW AROUND A HEATED CANNISTER

RESULTS ON YEAR 1.000

NODE	T(C)	H(M)	NODE	T(C)	H(M)	NODE	T(C)	H(M)
151	62.16	1.691	201	68.42	1.870	251	67.52	1.876
152	57.82	1.516	202	68.99	1.871	252	67.98	1.876
153	57.95	1.520	203	68.94	1.870	253	68.09	1.875
154	59.22	1.573	204	69.00	1.872	254	62.15	1.684
155	54.22	1.350	205	68.94	1.871	255	68.47	1.876
156	54.26	1.349	206	68.47	1.872	256	69.00	1.876
157	55.98	1.431	207	67.27	1.874	257	69.12	1.875
158	51.90	1.225	208	67.17	1.873	258	69.67	1.876
159	51.91	1.223	209	63.81	1.752	259	70.22	1.876
160	52.90	1.278	210	63.87	1.753	260	70.62	1.875
161	51.09	1.177	211	65.58	1.816	261	59.22	1.562
162	51.09	1.174	212	68.21	1.874	262	60.63	1.621
163	51.31	1.187	213	68.09	1.873	263	60.63	1.622
164	68.19	1.869	214	67.73	1.874	264	62.16	1.683
165	67.71	1.869	215	60.70	1.630	265	63.79	1.749
166	67.50	1.869	216	60.73	1.630	266	63.74	1.747
167	67.96	1.869	217	62.24	1.690	267	57.82	1.499
168	68.07	1.869	218	69.21	1.874	268	57.61	1.486
169	67.41	1.870	219	69.12	1.873	269	58.74	1.535
170	67.89	1.870	220	68.70	1.874	270	59.91	1.586
171	67.89	1.869	221	59.35	1.573	271	60.35	1.607
172	67.09	1.872	222	59.26	1.567	272	54.22	1.330
173	67.02	1.871	223	60.65	1.624	273	54.15	1.322
174	63.74	1.750	224	60.70	1.627	274	55.79	1.401
175	63.75	1.751	225	58.03	1.513	275	51.90	1.204
176	65.43	1.811	226	57.95	1.507	276	51.87	1.199
177	67.98	1.872	227	59.15	1.560	277	52.83	1.252
178	67.90	1.871	228	54.29	1.339	278	51.09	1.155
179	67.52	1.872	229	54.26	1.335	279	51.07	1.150
180	60.63	1.630	230	55.98	1.417	280	51.28	1.163
181	60.65	1.630	231	51.92	1.212	281	71.32	1.874
182	62.15	1.689	232	51.91	1.208	282	71.20	1.873
183	59.15	1.569	233	52.90	1.263	283	71.20	1.874
184	58.09	1.519	234	51.10	1.162	284	70.62	1.877
185	59.26	1.571	235	51.09	1.158	285	70.79	1.874
186	58.03	1.521	236	51.31	1.171	286	71.20	1.875
187	54.29	1.348	237	70.79	1.872	287	65.45	1.815
188	54.31	1.344	238	70.13	1.871	288	66.95	1.878
189	56.06	1.427	239	69.66	1.871	289	67.02	1.877
190	51.92	1.221	240	70.22	1.872	290	67.41	1.878
191	51.93	1.217	241	70.62	1.872	291	67.89	1.878
192	52.92	1.272	242	69.67	1.872	292	67.90	1.877
193	51.10	1.171	243	70.79	1.874	293	68.41	1.878
194	51.10	1.167	244	70.62	1.873	294	68.99	1.878
195	51.32	1.180	245	70.14	1.874	295	68.94	1.877
196	69.20	1.869	246	63.81	1.750	296	68.94	1.878
197	68.68	1.869	247	63.75	1.748	297	68.99	1.879
198	68.46	1.869	248	65.43	1.812	298	69.66	1.878
199	68.99	1.870	249	67.08	1.876	299	69.11	1.879
200	69.11	1.869	250	67.17	1.875	300	69.20	1.879

LISTING D-6. Output Report File for Test Case Two. (Sheet 15 of 48)

SAMPLE PROBLEM. FLOW AROUND A HEATED CANNISTER

RESULTS ON YEAR 1.000

NODE	T(C)	H(M)	NODE	T(C)	H(M)	NODE	T(C)	H(M)
301	70.13	1.878	350	54.47	1.312	399	54.56	1.294
302	61.09	1.635	351	56.94	1.431	400	52.69	1.186
303	62.17	1.680	352	57.22	1.444	401	51.78	1.125
304	63.13	1.721	353	58.50	1.509	402	51.90	1.132
305	63.09	1.718	354	51.67	1.170	403	51.99	1.137
306	63.74	1.745	355	51.55	1.155	404	53.03	1.204
307	65.43	1.815	356	52.32	1.199	405	51.77	1.137
308	57.28	1.466	357	57.40	1.452	406	51.19	1.093
309	56.82	1.440	358	57.52	1.457	407	51.52	1.111
310	57.68	1.479	359	58.94	1.528	408	52.06	1.140
311	58.49	1.515	360	50.96	1.124	409	52.10	1.143
312	59.29	1.555	361	50.89	1.115	410	53.22	1.213
313	54.04	1.312	362	51.06	1.126	411	50.86	1.084
314	53.87	1.298	363	67.25	1.880	412	50.58	1.057
315	55.32	1.369	364	67.14	1.880	413	50.86	1.073
316	59.21	1.546	365	63.73	1.743	414	52.13	1.144
317	59.78	1.571	366	63.79	1.745	415	52.15	1.145
318	61.04	1.629	367	65.53	1.815	416	53.29	1.217
319	51.83	1.191	368	67.71	1.880	417	50.50	1.061
320	51.77	1.182	369	60.50	1.601	418	50.34	1.041
321	52.66	1.233	370	60.53	1.603	419	50.40	1.045
322	51.05	1.144	371	62.11	1.673	420	52.17	1.146
323	51.01	1.136	372	58.85	1.523	421	53.32	1.219
324	51.21	1.148	373	57.63	1.463	422	52.16	1.146
325	67.06	1.880	374	58.95	1.528	423	50.89	1.063
326	67.00	1.879	375	57.59	1.460	424	50.00	*
327	63.68	1.741	376	59.04	1.532	425	50.00	*
328	63.68	1.742	377	54.58	1.307	426	50.00	*
329	65.39	1.811	378	53.62	1.247	427	50.99	1.068
330	67.96	1.879	379	53.90	1.261	428	50.60	1.047
331	67.89	1.879	380	54.13	1.273	429	50.00	*
332	67.50	1.879	381	55.30	1.342	430	50.00	*
333	68.46	1.879	382	52.85	1.218	431	50.00	*
334	68.07	1.879	383	52.33	1.179	432	50.00	*
335	68.19	1.879	384	53.03	1.217	433	51.04	1.071
336	68.68	1.879	385	54.29	1.281	434	50.29	1.029
337	60.20	1.589	386	54.41	1.287	435	50.00	*
338	60.46	1.601	387	55.73	1.362	436	50.00	*
339	62.07	1.672	388	51.35	1.133	437	50.00	*
340	60.45	1.600	389	51.12	1.110	438	50.00	*
341	60.46	1.600	390	51.65	1.141	439	51.04	1.072
342	62.03	1.670	391	54.49	1.291	440	50.17	1.021
343	56.24	1.406	392	54.53	1.293	441	50.00	*
344	55.53	1.365	393	55.91	1.371	442	50.00	*
345	56.08	1.391	394	50.78	1.098	443	50.00	*
346	56.56	1.413	395	50.65	1.080	444	51.07	1.072
347	57.57	1.467	396	50.77	1.088	445	50.00	*
348	53.64	1.279	397	54.58	1.295			
349	53.32	1.254	398	55.98	1.374			

ITERATION NUMBER 1. MAX CHANGE (TEMP) = 2.1629E-03, MAX REL CORRECTION = 4.2879E-03
 ITERATION NUMBER 1. MAX CHANGE (HEAD) = 7.6922E-02, MAX REL CORRECTION = 2.9814E-02

LISTING D-6. Output Report File for Test Case Two. (Sheet 16 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

RESULTS FOR VELOCITY (M/YR) OF YEAR 1.000

ELEMENT		GSS PNT 1	GSS PNT 2	GSS PNT 3	GSS PNT 4	GSS PNT 5	GSS PNT 6	GSS PNT 7	GSS PNT 8	GSS PNT 9
1	VEL X	1.7048E-07	3.5943E-07	7.2765E-07	9.2613E-08	1.9638E-07	3.9330E-07	2.0105E-08	4.2863E-08	8.4953E-08
	VEL Y	-1.7252E-05	-1.7197E-05	-1.7116E-05	-1.6977E-05	-1.6925E-05	-1.6848E-05	-1.6701E-05	-1.6652E-05	-1.6579E-05
2	VEL X	1.1890E-06	6.5240E-07	1.4304E-07	1.0124E-06	5.4966E-07	1.1918E-07	7.4884E-07	3.9562E-07	8.3232E-08
	VEL Y	-1.6717E-05	-1.6479E-05	-1.6239E-05	-1.6917E-05	-1.6667E-05	-1.6415E-05	-1.7054E-05	-1.6792E-05	-1.6528E-05
3	VEL X	1.9186E-06	1.0501E-06	2.2969E-07	1.6784E-06	9.1141E-07	1.9764E-07	1.3662E-06	7.3060E-07	1.5577E-07
	VEL Y	-1.5710E-05	-1.5540E-05	-1.5369E-05	-1.6187E-05	-1.5989E-05	-1.5790E-05	-1.6551E-05	-1.6325E-05	-1.6097E-05
4	VEL X	2.5867E-06	1.4148E-06	3.0921E-07	2.3749E-06	1.2922E-06	2.8087E-07	2.1171E-06	1.1428E-06	2.4632E-07
	VEL Y	-1.3761E-05	-1.3712E-05	-1.3662E-05	-1.4626E-05	-1.4527E-05	-1.4428E-05	-1.5346E-05	-1.5199E-05	-1.5050E-05
5	VEL X	2.7972E-06	1.5549E-06	3.4567E-07	2.7800E-06	1.5411E-06	3.4162E-07	2.7544E-06	1.5206E-06	3.3562E-07
	VEL Y	-8.4737E-06	-8.5906E-06	-8.7073E-06	-1.0918E-05	-1.0970E-05	-1.1020E-05	-1.2931E-05	-1.2916E-05	-1.2900E-05
6	VEL X	1.6199E-06	9.1389E-07	2.0623E-07	2.0561E-06	1.1598E-06	2.6170E-07	2.6216E-06	1.4787E-06	3.3361E-07
	VEL Y	-2.1025E-06	-2.2170E-06	-2.3315E-06	-4.3496E-06	-4.4727E-06	-4.5958E-06	-6.8596E-06	-6.9920E-06	-7.1242E-06
7	VEL X	1.7952E-07	1.0418E-07	2.4165E-08	6.7210E-07	3.8205E-07	8.6864E-08	1.2703E-06	7.1950E-07	1.6301E-07
	VEL Y	1.0864E-06	1.0205E-06	9.5463E-07	4.3522E-07	3.5013E-07	2.6497E-07	-9.5083E-07	-1.0563E-06	-1.1619E-06
8	VEL X	4.8666E-07	9.4404E-07	1.9007E-06	3.3969E-07	6.8455E-07	1.3860E-06	2.2763E-07	4.7583E-07	9.6709E-07
	VEL Y	-1.9630E-05	-1.9531E-05	-1.9401E-05	-1.8596E-05	-1.8515E-05	-1.8407E-05	-1.7557E-05	-1.7495E-05	-1.7408E-05
9	VEL X	3.0888E-06	2.2696E-06	1.5784E-06	2.6532E-06	1.9192E-06	1.3372E-06	2.0115E-06	1.4005E-06	9.7844E-07
	VEL Y	-1.8707E-05	-1.7846E-05	-1.6982E-05	-1.9038E-05	-1.8123E-05	-1.7203E-05	-1.9284E-05	-1.8315E-05	-1.7340E-05
10	VEL X	4.9064E-06	3.6198E-06	2.5368E-06	4.3364E-06	3.1610E-06	2.2140E-06	3.5989E-06	2.5663E-06	1.7947E-06
	VEL Y	-1.7036E-05	-1.6471E-05	-1.5903E-05	-1.7793E-05	-1.7107E-05	-1.6417E-05	-1.8404E-05	-1.7596E-05	-1.6785E-05
11	VEL X	6.3310E-06	4.7330E-06	3.3842E-06	5.8891E-06	4.3628E-06	3.1079E-06	5.3532E-06	3.9132E-06	2.7719E-06
	VEL Y	-1.4083E-05	-1.3991E-05	-1.3897E-05	-1.5335E-05	-1.5052E-05	-1.4768E-05	-1.6428E-05	-1.5955E-05	-1.5480E-05
12	VEL X	6.2221E-06	4.8619E-06	3.5976E-06	6.3770E-06	4.9297E-06	3.5966E-06	6.6064E-06	5.0299E-06	3.5952E-06
	VEL Y	-7.5728E-06	-7.9890E-06	-8.4055E-06	-1.0380E-05	-1.0599E-05	-1.0818E-05	-1.2877E-05	-1.2899E-05	-1.2918E-05
13	VEL X	3.3645E-06	2.7148E-06	2.0494E-06	4.3689E-06	3.4998E-06	2.6132E-06	5.6710E-06	4.5177E-06	3.3441E-06
	VEL Y	-1.2617E-06	-1.6100E-06	-1.9588E-06	-3.3570E-06	-3.7561E-06	-4.1556E-06	-5.8096E-06	-6.2604E-06	-6.7116E-06
14	VEL X	3.6741E-07	3.0478E-07	2.2740E-07	1.3871E-06	1.1244E-06	8.4557E-07	2.6253E-06	2.1198E-06	1.5963E-06
	VEL Y	1.5735E-06	1.3790E-06	1.1843E-06	1.0179E-06	7.6503E-07	5.1181E-07	-2.2182E-07	-5.3424E-07	-8.4707E-07
15	VEL X	1.1926E-06	2.2599E-06	4.6667E-06	8.1373E-07	1.5956E-06	3.3070E-06	5.9219E-07	1.1566E-06	2.3567E-06
	VEL Y	-2.5849E-05	-2.5576E-05	-2.5234E-05	-2.3140E-05	-2.2953E-05	-2.2703E-05	-2.0422E-05	-2.0320E-05	-2.0159E-05
16	VEL X	7.3130E-06	5.3126E-06	3.8201E-06	6.2657E-06	4.4548E-06	3.2456E-06	4.7415E-06	3.2007E-06	2.4016E-06
	VEL Y	-2.3393E-05	-2.1395E-05	-1.9387E-05	-2.4255E-05	-2.2039E-05	-1.9812E-05	-2.4921E-05	-2.2486E-05	-2.0038E-05

LISTING D-6. Output Report File for Test Case Two. (Sheet 17 of 48)

SAMPLE PROBLEM: FLOW AROUND A HEATED CANNISTER

RESULTS FOR VELOCITY (M/YR) OF YEAR 1.000

ELEMENT		GSS PNT 1	GSS PNT 2	GSS PNT 3	GSS PNT 4	GSS PNT 5	GSS PNT 6	GSS PNT 7	GSS PNT 8	GSS PNT 9
17	VEL X	1.0697E-05	7.9920E-06	5.9726E-06	9.6360E-06	7.0696E-06	5.2722E-06	8.2708E-06	5.8804E-06	4.3672E-06
	VEL Y	-1.9489E-05	-1.8501E-05	-1.7508E-05	-2.1185E-05	-1.9787E-05	-1.8384E-05	-2.2628E-05	-2.0821E-05	-1.9006E-05
18	VEL X	1.2180E-05	9.5584E-06	7.5390E-06	1.1767E-05	9.0839E-06	7.0579E-06	1.1268E-05	8.5093E-06	6.4734E-06
	VEL Y	-1.3978E-05	-1.4172E-05	-1.4364E-05	-1.6162E-05	-1.5895E-05	-1.5625E-05	-1.8215E-05	-1.7487E-05	-1.6756E-05
19	VEL X	9.9379E-06	8.4865E-06	7.1582E-06	1.0887E-05	9.0884E-06	7.4362E-06	1.2293E-05	9.9794E-06	7.8478E-06
	VEL Y	-5.5016E-06	-6.4027E-06	-7.3050E-06	-8.7287E-06	-9.3764E-06	-1.0024E-05	-1.2076E-05	-1.2471E-05	-1.2865E-05
20	VEL X	4.8654E-06	4.3459E-06	3.7738E-06	6.5481E-06	5.7707E-06	4.9339E-06	8.7297E-06	7.6179E-06	6.4380E-06
	VEL Y	1.9931E-07	-3.7731E-07	-9.5478E-07	-1.5124E-06	-2.2508E-06	-2.9903E-06	-3.7258E-06	-4.6274E-06	-5.5303E-06
21	VEL X	5.1939E-07	4.7584E-07	4.0913E-07	1.9930E-06	1.7811E-06	1.5438E-06	3.7827E-06	3.3663E-06	2.9218E-06
	VEL Y	2.3820E-06	2.0715E-06	1.7606E-06	1.9723E-06	1.5709E-06	1.1688E-06	9.8723E-07	4.9378E-07	-4.0647E-10
22	VEL X	3.6104E-06	5.5274E-06	3.0515E-06	2.7628E-06	1.6983E-06	5.3690E-06	5.0480E-06		
	VEL Y	-2.9921E-05	-3.0980E-05	-3.1776E-05	-2.7040E-05	-2.8189E-05	-2.6655E-05	-3.4950E-05		
23	VEL X	7.8850E-06	7.8811E-06	8.6322E-06	6.6132E-06	7.1700E-06	4.7852E-06	1.0536E-05		
	VEL Y	-3.3340E-05	-3.1666E-05	-3.6746E-05	-3.1853E-05	-3.6192E-05	-2.8328E-05	-3.6160E-05		
24	VEL X	1.5802E-05	1.1956E-05	8.9889E-06	1.3850E-05	1.0263E-05	7.7107E-06	1.1040E-05	7.8147E-06	5.8550E-06
	VEL Y	-3.0503E-05	-2.7564E-05	-2.5127E-05	-3.3101E-05	-2.9389E-05	-2.6303E-05	-3.5172E-05	-3.0736E-05	-2.7038E-05
25	VEL X	1.5711E-06	3.0733E-06	1.5414E-08	2.2476E-06	4.0744E-07	5.3086E-06	7.7587E-07		
	VEL Y	-3.4426E-05	-3.7868E-05	-3.3002E-05	-3.2740E-05	-2.9437E-05	-3.7033E-05	-3.7734E-05		
26	VEL X	1.9959E-05	1.6004E-05	1.2792E-05	1.8799E-05	1.4805E-05	1.1640E-05	1.7315E-05	1.3267E-05	1.0159E-05
	VEL Y	-2.1118E-05	-2.0636E-05	-2.0248E-05	-2.4962E-05	-2.3495E-05	-2.2288E-05	-2.8435E-05	-2.6023E-05	-2.4027E-05
27	VEL X	1.8848E-05	1.6334E-05	1.4032E-05	1.9367E-05	1.6443E-05	1.3749E-05	1.9995E-05	1.6576E-05	1.3406E-05
	VEL Y	-1.1968E-05	-1.3022E-05	-1.3903E-05	-1.5191E-05	-1.5712E-05	-1.6154E-05	-1.8604E-05	-1.8581E-05	-1.8572E-05
28	VEL X	1.2646E-05	1.1812E-05	1.0845E-05	1.4871E-05	1.3550E-05	1.2092E-05	1.8165E-05	1.6122E-05	1.3908E-05
	VEL Y	-2.6608E-06	-3.8245E-06	-4.7890E-06	-5.6210E-06	-6.8404E-06	-7.8534E-06	-9.4783E-06	-1.0674E-05	-1.1670E-05
29	VEL X	5.7319E-06	5.4928E-06	5.1641E-06	7.9320E-06	7.5137E-06	6.9941E-06	1.0785E-05	1.0134E-05	9.3667E-06
	VEL Y	1.7134E-06	1.1376E-06	6.6229E-07	5.2688E-07	-3.1102E-07	-1.0035E-06	-1.2646E-06	-2.3082E-06	-3.1721E-06
30	VEL X	6.0301E-07	5.8698E-07	5.4641E-07	2.3370E-06	2.2330E-06	2.1020E-06	4.4429E-06	4.2320E-06	3.9911E-06
	VEL Y	3.1792E-06	2.8824E-06	2.6392E-06	2.9244E-06	2.5190E-06	2.1851E-06	2.2004E-06	1.7323E-06	1.3461E-06
31	VEL X	1.2363E-05	9.2098E-06	7.1037E-06	6.9243E-06	5.1363E-06	3.8828E-06	2.2928E-06	1.7933E-06	1.3287E-06
	VEL Y	-5.6787E-05	-4.7694E-05	-4.0658E-05	-5.7767E-05	-4.8344E-05	-4.1095E-05	-5.8426E-05	-4.8805E-05	-4.1424E-05
32	VEL X	2.4079E-05	1.6887E-05	1.2051E-05	1.9897E-05	1.3873E-05	9.7235E-06	1.6468E-05	1.1564E-05	8.0651E-06
	VEL Y	-5.3362E-05	-4.5429E-05	-3.9177E-05	-5.4555E-05	-4.6205E-05	-3.9666E-05	-5.5958E-05	-4.7151E-05	-4.0305E-05

LISTING D-6. Output Report File for Test Case Two. (Sheet 18 of 48)

SAMPLE PROBLEM: FLOW AROUND A HEATED CANNISTER

RESULTS FOR VELOCITY (M/YR) OF YEAR 1.000

ELEMENT		GSS PNT 1	GSS PNT 2	GSS PNT 3	GSS PNT 4	GSS PNT 5	GSS PNT 6	GSS PNT 7	GSS PNT 8	GSS PNT 9
33	VEL X	3.4073E-05	2.5694E-05	1.9220E-05	3.0615E-05	2.2638E-05	1.6878E-05	2.5703E-05	1.8271E-05	1.3514E-05
	VEL Y	-3.7009E-05	-3.4612E-05	-3.2745E-05	-4.4808E-05	-3.9939E-05	-3.6118E-05	-5.1165E-05	-4.4016E-05	-3.8377E-05
34	VEL X	3.1613E-05	2.7009E-05	2.2911E-05	3.2680E-05	2.7073E-05	2.2017E-05	3.4045E-05	2.7159E-05	2.0876E-05
	VEL Y	-1.8445E-05	-1.9963E-05	-2.1166E-05	-2.4852E-05	-2.5027E-05	-2.5181E-05	-3.1746E-05	-3.0540E-05	-2.9613E-05
35	VEL X	2.4590E-05	2.2750E-05	2.0633E-05	2.7128E-05	2.4484E-05	2.1533E-05	3.0181E-05	2.6573E-05	2.2620E-05
	VEL Y	-7.5119E-06	-9.5218E-06	-1.1094E-05	-1.0733E-05	-1.2746E-05	-1.4326E-05	-1.4896E-05	-1.6803E-05	-1.8306E-05
36	VEL X	1.4196E-05	1.3785E-05	1.3199E-05	1.7627E-05	1.6762E-05	1.5728E-05	2.2706E-05	2.1219E-05	1.9472E-05
	VEL Y	1.8914E-07	-9.9535E-07	-1.9152E-06	-1.8836E-06	-3.4943E-06	-4.7484E-06	-5.2851E-06	-7.1585E-06	-8.6214E-06
37	VEL X	6.1575E-06	6.0465E-06	5.8730E-06	8.6718E-06	8.4550E-06	8.1679E-06	1.1931E-05	1.1578E-05	1.1143E-05
	VEL Y	2.9739E-06	2.4682E-06	2.0778E-06	2.2306E-06	1.4723E-06	8.8574E-07	9.7869E-07	3.3319E-08	-6.9978E-07
38	VEL X	6.4235E-07	6.3606E-07	6.1382E-07	2.5076E-06	2.4576E-06	2.3902E-06	4.7726E-06	4.6697E-06	4.5474E-06
	VEL Y	3.8187E-06	3.5692E-06	3.3777E-06	3.6757E-06	3.3288E-06	3.0620E-06	3.2125E-06	2.8112E-06	2.5018E-06
39	VEL X	2.6730E-05	2.1229E-05	1.5602E-05	1.1711E-05	1.0978E-05	8.7996E-06	-1.5662E-06	1.9427E-06	2.7786E-06
	VEL Y	-9.1932E-05	-7.4819E-05	-6.3245E-05	-9.1923E-05	-7.5860E-05	-6.5120E-05	-8.9739E-05	-7.5524E-05	-6.6047E-05
40	VEL X	6.1668E-05	4.3047E-05	3.0616E-05	4.8129E-05	3.3099E-05	2.4504E-05	3.3948E-05	2.3497E-05	1.9000E-05
	VEL Y	-7.8120E-05	-6.7818E-05	-6.0497E-05	-8.4560E-05	-7.1360E-05	-6.2057E-05	-9.0224E-05	-7.3903E-05	-6.2578E-05
41	VEL X	5.8872E-05	4.8463E-05	4.0163E-05	6.3322E-05	4.9224E-05	3.7477E-05	6.9607E-05	5.0308E-05	3.3667E-05
	VEL Y	-3.2053E-05	-3.5466E-05	-3.7896E-05	-4.9391E-05	-4.7365E-05	-4.5963E-05	-6.8885E-05	-6.1205E-05	-5.5790E-05
42	VEL X	4.1061E-05	3.8515E-05	3.4931E-05	4.6943E-05	4.2524E-05	3.6935E-05	5.4382E-05	4.7611E-05	3.9486E-05
	VEL Y	-1.0378E-05	-1.4076E-05	-1.6663E-05	-1.5693E-05	-2.0156E-05	-2.3296E-05	-2.3706E-05	-2.8479E-05	-3.1859E-05
43	VEL X	2.7885E-05	2.7073E-05	2.5792E-05	3.2267E-05	3.0789E-05	2.8801E-05	3.7512E-05	3.5246E-05	3.2417E-05
	VEL Y	-2.2379E-06	-4.4657E-06	-6.0059E-06	-4.3339E-06	-7.1768E-06	-9.1508E-06	-7.7955E-06	-1.1005E-05	-1.3245E-05
44	VEL X	1.4884E-05	1.4738E-05	1.4460E-05	1.9016E-05	1.8641E-05	1.8108E-05	2.5128E-05	2.4415E-05	2.3506E-05
	VEL Y	2.4396E-06	1.4877E-06	8.3797E-07	1.3439E-06	-1.7493E-07	-1.2166E-06	-9.3558E-07	-2.7973E-06	-4.0810E-06
45	VEL X	6.3337E-06	6.2923E-06	6.2184E-06	8.9928E-06	8.9057E-06	8.7823E-06	1.2439E-05	1.2294E-05	1.2106E-05
	VEL Y	3.8755E-06	3.4976E-06	3.2430E-06	3.4685E-06	2.8999E-06	2.5149E-06	2.7092E-06	2.0205E-06	1.5517E-06
46	VEL X	6.5827E-07	6.5657E-07	6.4639E-07	2.5785E-06	2.5594E-06	2.5312E-06	4.9100E-06	4.8701E-06	4.8199E-06
	VEL Y	4.2652E-06	4.0885E-06	3.9709E-06	4.2044E-06	3.9460E-06	3.7734E-06	3.9400E-06	3.6429E-06	3.4434E-06
47	VEL X	-2.1876E-05	-2.4482E-05	-2.7196E-05	-1.1984E-05	-1.1896E-05	-1.1840E-05	-2.3036E-05	5.2846E-07	3.5064E-06
	VEL Y	-7.8169E-05	-9.2052E-05	-1.0454E-04	-6.7419E-05	-8.1542E-05	-9.4539E-05	-5.2952E-05	-6.6961E-05	-8.0090E-05
48	VEL X	-5.9221E-06	-7.3533E-06	-9.0241E-06	-1.6321E-05	-1.7760E-05	-1.9357E-05	-1.9833E-05	-2.1152E-05	-2.2483E-05
	VEL Y	-1.1438E-04	-1.3105E-04	-1.4595E-04	-1.0003E-04	-1.1471E-04	-1.2772E-04	-8.4124E-05	-9.7697E-05	-1.0974E-04

LISTING D-6. Output Report File for Test Case Two. (Sheet 19 of 48)

SAMPLE PROBLEM, FLUID AROUND A HEATED CANNISTER

RESULTS FOR VELOCIT Y (M/VR) OF YEAR 1.000

ELEMENT	VEL X	VEL Y	VEL Z	
49	6.6953E-05 6.6013E-05 6.4019E-05 7.4803E-05 7.8252E-05 7.0396E-05 9.4453E-05 8.7199E-05 7.9310E-05	-1.7077E-05 -2.2801E-05 -2.9051E-05 -2.2741E-05 -3.251AE-05 -4.2386E-05 -3.5136E-05 -4.9226E-05 -6.2180E-05	9SS PNT 1 9SS PNT 2 9SS PNT 3 9SS PNT 4 9SS PNT 5 9SS PNT 6 9SS PNT 7 9SS PNT 8 9SS PNT 9	
50	3.8256E-05 3.8376E-05 3.5053E-05 3.7660E-05 3.1.4596E-04 -1.7136E-04 -1.5594E-04 -1.5799E-04 -1.5351E-07 3.1.994E-05 1.6976E-05 1.4094E-06	-1.7787E-04 -1.7136E-04 -1.5594E-04 -1.5799E-04 -1.5351E-07 3.1.994E-05 1.6976E-05 1.4094E-06	4.3329E-05 4.2576E-05 4.2008E-05 5.0665E-05 4.9500E-05 4.8552E-05 6.0075E-05 4.8552E-05 5.8316E-05 5.6831E-05	VEL X VEL Y
51	VEL X	VEL Y	VEL Z	
52	3.5262E-05 3.9272E-05 3.3297E-05 3.3503E-05 2.9356E-05 3.8617E-05 3.8590E-05	-4.3700E-06 -5.1982E-06 -4.3325E-06 -2.9550E-06 -8.3142E-07 -3.5720E-06 -7.3239E-06	-4.4312E-06 -6.2747E-06 -8.8588E-06 -8.4468E-06 -1.0925E-05 -1.4140E-05 -1.4175E-05 -1.7776E-05 -2.2118E-05	VEL X VEL Y
53	3.1320E-05 3.5199E-05 1.5074E-05 1.4966E-05 2.7926E-05 3.3516E-05 2.9276E-05 3.7260E-05 2.7442E-05	-5.5265E-07 -1.7532E-06 1.5269E-06 1.2663E-06 2.8407E-06 1.0877E-06 -1.6550E-06	5.5265E-07 3.2556E-05 2.7926E-05 3.3516E-05 2.9276E-05 3.7260E-05 2.7442E-05	VEL X VEL Y
54	1.3159E-05 1.5199E-05 1.5074E-05 1.4966E-05 2.7926E-05 3.1.9427E-05 1.9202E-05 2.6228E-05 2.5871E-05 2.5471E-05	-4.3922E-06 3.7817E-06 2.4840E-06 4.0158E-06 4.0158E-06 3.1346E-06 1.2067E-06 3.3504E-06 2.6076E-06 8.1823E-07	4.3922E-06 3.7817E-06 2.4840E-06 4.0158E-06 4.0158E-06 3.1346E-06 1.2067E-06 3.3504E-06 2.6076E-06 8.1823E-07	VEL X VEL Y
55	3.4098E-06 6.3848E-06 6.3544E-06 6.4075E-06 9.1342E-06 9.0884E-06 9.0349E-06 1.2667E-06 1.2667E-06 1.2594E-05	4.6616E-06 4.4075E-06 3.9046E-06 3.9442E-06 4.1820E-06 4.1820E-06 3.4688E-06 4.3264E-06 3.8423E-06 2.8303E-06	4.6616E-06 4.4075E-06 3.9046E-06 3.9442E-06 4.1820E-06 4.1820E-06 3.4688E-06 4.3264E-06 3.8423E-06 2.8303E-06	VEL X VEL Y
56	6.6357E-07 6.6230E-07 6.5880E-07 2.6097E-06 2.5997E-06 4.4974E-06 4.9731E-06 4.9525E-06 4.9525E-06 3.9751E-06	4.6816E-06 4.5474E-06 4.2994E-06 4.2994E-06 4.5929E-06 4.5929E-06 4.9731E-06 4.9525E-06 4.9525E-06 3.9751E-06	4.6816E-06 4.5474E-06 4.2994E-06 4.2994E-06 4.5929E-06 4.5929E-06 4.9731E-06 4.9525E-06 4.9525E-06 3.9751E-06	VEL X VEL Y
57	-1.8130E-05 -1.9362E-05 -2.1244E-05 -2.1820E-05 -1.1.9388E-05 -1.2410E-05 -1.2410E-05 -4.7520E-06 -3.9988E-06 -3.3397E-06	-4.5616E-05 -5.8769E-05 -7.0123E-05 -7.2.9401E-05 -4.3740E-05 -5.6662E-05 -5.6662E-05 -1.9066E-05 -3.3609E-05 -4.7149E-05	-4.5616E-05 -5.8769E-05 -7.0123E-05 -7.2.9401E-05 -4.3740E-05 -5.6662E-05 -5.6662E-05 -1.9066E-05 -3.3609E-05 -4.7149E-05	VEL X VEL Y
58	3.5753E-06 -1.3424E-06 -1.3424E-06 -1.0571E-06 -5.9091E-06 -1.0571E-06 -1.4927E-05 -1.1.4454E-05 -1.5212E-05 -1.5212E-05	-6.4693E-05 -8.5733E-05 -1.0402E-04 -6.1692E-05 -7.7.5961E-05 -1.2961E-05 -1.3093E-05 -6.6859E-05 -1.8406E-05 -7.8406E-05	-6.4693E-05 -8.5733E-05 -1.0402E-04 -6.1692E-05 -7.7.5961E-05 -1.2961E-05 -1.3093E-05 -6.6859E-05 -1.8406E-05 -7.8406E-05	VEL X VEL Y
59	3.5429E-05 1.7657E-05 1.7840E-05 3.5200E-05 1.9388E-05 1.2952E-05 2.2952E-05 3.5112E-05 2.1063E-05 3.7964E-06	-1.2636E-04 -1.2532E-04 -1.1290E-04 -1.0322E-04 -1.0543E-04 -1.2952E-05 -7.7.4976E-05 -8.3.3261E-05 -2.1063E-05 -7.6337E-05	-1.2636E-04 -1.2532E-04 -1.1290E-04 -1.0322E-04 -1.0543E-04 -1.2952E-05 -7.7.4976E-05 -8.3.3261E-05 -2.1063E-05 -7.6337E-05	VEL X VEL Y
60	7.2005E-05 7.0475E-05 6.7947E-05 8.2307E-05 8.1772E-05 7.9721E-05 9.7702E-05 9.8488E-05 9.7069E-05 9.7875E-05	1.1662E-07 -6.3472E-06 -1.3533E-05 -1.3083E-05 8.1772E-05 7.9721E-05 2.6020E-06 2.1182E-06 -1.2168E-05 -1.2168E-05	1.1662E-07 -6.3472E-06 -1.3533E-05 -1.3083E-05 8.1772E-05 7.9721E-05 2.6020E-06 2.1182E-06 -1.2168E-05 -1.2168E-05	VEL X VEL Y
61	9.1053E-05 8.2043E-05 5.6883E-05 8.5033E-05 7.6881E-05 5.1804E-05 7.9046E-05 7.1734E-05 4.6676E-05 3.9764E-06	-1.8500E-04 -1.8172E-04 -1.6852E-04 -1.5994E-04 -1.6084E-04 -1.5254E-04 -1.3382E-04 -1.3571E-04 -1.3571E-04 -1.3571E-04	-1.8500E-04 -1.8172E-04 -1.6852E-04 -1.5994E-04 -1.6084E-04 -1.5254E-04 -1.3382E-04 -1.3571E-04 -1.3571E-04 -1.3571E-04	VEL X VEL Y
62	4.4828E-05 4.4326E-05 4.3757E-05 5.3034E-05 5.2256E-05 5.1357E-05 6.3708E-05 6.2558E-05 6.1148E-05 3.9764E-06	3.0580E-06 1.8848E-07 -3.4200E-06 2.1460E-06 -1.5033E-06 -5.9168E-06 9.5628E-07 -4.0192E-06 -9.7878E-06 -9.7878E-06	3.0580E-06 1.8848E-07 -3.4200E-06 2.1460E-06 -1.5033E-06 -5.9168E-06 9.5628E-07 -4.0192E-06 -9.7878E-06 -9.7878E-06	VEL X VEL Y
63	7.6609E-05 6.0912E-05 4.4793E-05 5.9587E-05 5.6594E-05 4.2883E-05 5.2321E-05 4.1027E-05 5.1027E-05 3.9546E-05	-1.2091E-04 -1.2609E-04 -1.2580E-04 -9.6694E-05 -1.0148E-04 -1.0226E-04 -7.0762E-05 -7.4937E-05 -7.4937E-05 -7.4937E-05	-1.2091E-04 -1.2609E-04 -1.2580E-04 -9.6694E-05 -1.0148E-04 -1.0226E-04 -7.0762E-05 -7.4937E-05 -7.4937E-05 -7.4937E-05	VEL X VEL Y
64	3.6664E-05 3.4613E-05 3.3011E-05 4.0764E-05 4.0755E-05 3.9696E-05 3.0721E-05 4.3670E-06 4.3670E-06 3.0721E-05	2.8680E-06 2.1760E-06 4.6778E-06 1.0325E-06 3.6595E-06 -1.4724E-06 4.3670E-06	2.8680E-06 2.1760E-06 4.6778E-06 1.0325E-06 3.6595E-06 -1.4724E-06 4.3670E-06	VEL X VEL Y

LISTING D-6. Output Report File for Test Case Two. (Sheet 20 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

RESULTS FOR VELOCITY (M/YR) OF YEAR 1.000

ELEMENT	GSS PNT 1	GSS PNT 2	GSS PNT 3	GSS PNT 4	GSS PNT 5	GSS PNT 6	GSS PNT 7	GSS PNT 8	GSS PNT 9
65 VEL X	3.6842E-05	3.4960E-05	4.1020E-05	3.5044E-05	4.0732E-05	3.0774E-05	4.0116E-05		
VEL Y	6.4818E-06	7.3677E-06	8.0356E-06	4.7879E-06	5.4224E-06	5.5114E-06	1.0634E-05		
66 VEL X	3.1690E-05	3.3097E-05	3.3854E-05	2.8149E-05	2.9377E-05	2.7863E-05	3.7838E-05		
VEL Y	9.1498E-06	1.1299E-05	8.4225E-06	8.3262E-06	6.9948E-06	1.1477E-05	1.0559E-05		
67 VEL X	2.5791E-05	1.9402E-05	1.5084E-05	2.6079E-05	1.9562E-05	1.5160E-05	2.6281E-05	1.9657E-05	1.5182E-05
VEL Y	1.0514E-05	8.7491E-06	7.5576E-06	7.5631E-06	6.7511E-06	6.2640E-06	4.2556E-06	5.8388E-06	5.6560E-06
68 VEL X	1.2597E-05	9.0914E-06	6.3871E-06	1.2648E-05	9.1249E-06	6.4074E-06	1.2681E-05	9.1434E-06	6.4150E-06
VEL Y	6.8115E-06	6.2854E-06	5.8937E-06	5.8210E-06	5.5654E-06	5.3913E-06	5.3477E-06	5.2116E-06	5.1374E-06
69 VEL X	4.9542E-06	2.6000E-06	6.6131E-07	4.9681E-06	2.6081E-06	6.6477E-07	4.9769E-06	2.6118E-06	6.6437E-07
VEL Y	5.5862E-06	5.4062E-06	5.2962E-06	5.1812E-06	5.0925E-06	5.0518E-06	4.9734E-06	4.9272E-06	4.9197E-06
70 VEL X	-1.5282E-04	-2.0021E-04	-2.6993E-04	-8.1818E-05	-1.1443E-04	-1.4331E-04	-2.5505E-05	-4.7079E-05	-4.9980E-05
VEL Y	2.2603E-04	1.3795E-04	3.2503E-05	3.8703E-04	2.7367E-04	9.3343E-05	4.4666E-04	3.5343E-04	1.5087E-04
71 VEL X	-2.1587E-04	-2.8682E-04	-3.2433E-04	-1.8917E-04	-2.5778E-04	-3.1164E-04	-1.7804E-04	-2.3763E-04	-2.7114E-04
VEL Y	-3.8977E-04	-3.6860E-04	-2.7500E-04	-1.3109E-04	-1.7073E-04	-1.5904E-04	1.0014E-04	3.1392E-05	-3.5598E-05
72 VEL X	4.1620E-05	-4.0283E-05	-1.4052E-04	2.9165E-05	-4.9107E-05	-1.3003E-04	1.5909E-05	-6.1643E-05	-1.3083E-04
VEL Y	-4.9498E-04	-4.8218E-04	-4.4359E-04	-6.6315E-05	-8.7467E-05	-1.3318E-04	2.4785E-04	2.2635E-04	1.3710E-04
73 VEL X	1.0386E-04	8.3876E-05	7.0332E-05	1.0255E-04	8.4189E-05	7.1888E-05	9.8654E-05	8.2882E-05	7.2336E-05
VEL Y	3.0628E-05	2.5806E-05	2.0578E-05	1.3474E-05	1.4187E-05	1.2904E-05	-1.3198E-06	4.1520E-06	6.2204E-06
74 VEL X	1.3836E-04	1.4356E-04	1.4899E-04	1.1686E-04	1.2245E-04	1.2815E-04	8.7365E-05	9.3504E-05	9.9668E-05
VEL Y	-7.3771E-05	-9.1602E-05	-1.0853E-04	-1.0327E-04	-1.2120E-04	-1.3838E-04	-1.2079E-04	-1.3920E-04	-1.5698E-04
75 VEL X	6.2999E-05	5.2549E-05	4.4448E-05	6.3682E-05	5.2994E-05	4.4758E-05	6.3978E-05	5.3210E-05	4.4935E-05
VEL Y	1.7325E-05	1.4494E-05	1.2652E-05	1.1183E-05	9.8667E-06	8.9530E-06	6.0237E-06	6.1071E-06	6.0374E-06
76 VEL X	1.2175E-04	1.2730E-04	1.3314E-04	1.0058E-04	1.0711E-04	1.1379E-04	7.3742E-05	8.1306E-05	8.8898E-05
VEL Y	-2.4165E-05	-4.5061E-05	-6.4859E-05	-5.1601E-05	-7.3001E-05	-9.3527E-05	-6.7613E-05	-8.9529E-05	-1.1082E-04
77 VEL X	2.2337E-04	2.4729E-04	2.8695E-04	1.5204E-04	1.6222E-04	1.7783E-04	6.9952E-05	7.9859E-05	9.0929E-05
VEL Y	2.1716E-04	-5.0784E-05	-3.5315E-04	2.6998E-04	-4.1715E-05	-4.3261E-04	2.6000E-04	-5.0373E-05	-4.7554E-04
78 VEL X	3.6003E-05	4.0164E-05	3.4114E-05	3.4026E-05	2.9862E-05	3.9587E-05	3.9364E-05		
VEL Y	1.3910E-05	1.4447E-05	1.2533E-05	1.4131E-05	1.0800E-05	1.6740E-05	1.2796E-05		
79 VEL X	6.0058E-05	5.0619E-05	4.3165E-05	6.1064E-05	5.1259E-05	4.3567E-05	6.2277E-05	5.2077E-05	4.4137E-05
VEL Y	3.0578E-05	2.3163E-05	1.8299E-05	2.5843E-05	1.9761E-05	1.5624E-05	2.2028E-05	1.7194E-05	1.3739E-05
80 VEL X	3.3808E-05	2.9828E-05	2.6515E-05	3.6476E-05	3.1684E-05	2.7689E-05	3.8577E-05	3.3027E-05	2.8390E-05
VEL Y	2.3183E-05	1.9198E-05	1.6143E-05	2.0789E-05	1.7109E-05	1.4527E-05	1.7330E-05	1.4080E-05	1.2174E-05

LISTING D-6. Output Report File for Test Case Two. (Sheet 21 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

RESULTS FOR VELDCTY (M/YR) OF YEAR 3,000

ELEMENT OSS PNT 1 OSS PNT 2 OSS PNT 3 OSS PNT 4 OSS PNT 5 OSS PNT 6 OSS PNT 7 OSS PNT 8 OSS PNT 9

VEL X 1.3900E-05 1.8460E-05 1.4666E-05 2.4880E-05 1.1192E-05 1.8927E-05 1.0125E-05 1.4903E-05 2.5498E-05 1.9244E-05 1.5015E-05

VEL Y 1.2270E-05 8.8871E-06 6.2277E-06 1.2431E-06 6.5641E-06 7.6645E-06 8.9890E-06 6.3385E-06 1.2542E-05 9.0582E-06 6.3703E-06

VEL X 6.1300E-06 4.8681E-06 2.5937E-06 6.4972E-07 4.9088E-06 5.6326E-06 2.5782E-06 6.8988E-07 4.9422E-06 2.5578E-07 8.1833E-06

VEL Y 1.6799E-05 4.4225E-05 3.7263E-04 1.1458E-04 8.3314E-04 5.6052E-04 5.4689E-04 4.2747E-04 6.3037E-04 5.7140E-04 5.1637E-04

VEL X 5.8664E-04 1.0131E-04 1.9225E-04 1.9014E-04 3.6600E-04 6.5718E-05 1.1651E-04 5.7327E-04 6.7327E-04 5.8787E-04 4.1540E-04

VEL Y 9.0514E-05 7.7675E-05 5.1190E-05 6.8515E-05 9.7083E-05 6.9840E-05 8.1118E-05 3.9498E-05 5.6940E-05 3.7721E-05 4.14662E-04

VEL X 7.1932E-05 7.7675E-05 5.1190E-05 6.8515E-05 9.7083E-05 6.9840E-05 8.1118E-05 3.9498E-05 5.6940E-05 3.7721E-05 4.14662E-04

VEL Y 2.1438E-05 1.6150E-04 1.7052E-04 1.5466E-04 1.6205E-04 1.6948E-04 1.4511E-04 1.5088E-04 1.5383E-05 6.9833E-05 8.4494E-04

VEL X 1.5325E-04 1.6150E-04 1.6205E-04 1.6948E-04 1.7052E-04 1.5466E-04 1.4511E-04 1.5088E-04 1.5383E-05 6.9833E-05 8.4494E-04

VEL Y 5.1212E-04 1.3369E-04 1.4662E-04 1.3254E-04 1.4256E-04 1.4256E-04 1.5277E-04 1.2856E-04 1.3512E-04 1.4170E-04

VEL X 3.6755E-04 4.2369E-04 4.4230E-04 3.3207E-04 3.7318E-04 4.2641E-04 2.7199E-04 3.0697E-04 2.7199E-04 3.6224E-04

VEL Y 1.1312E-04 -1.7147E-05 -1.5516E-04 1.5081E-04 3.7318E-04 5.3841E-05 -2.5545E-04 1.9461E-04 -3.4667E-04 -2.9252E-04

VEL X 3.8234E-05 4.1617E-05 4.4003E-05 5.7870E-05 5.4804E-05 5.2639E-05 8.0089E-05 5.2639E-05 7.0306E-05 3.3656E-05

VEL Y 7.0077E-05 5.8493E-05 4.4943E-05 5.7870E-05 5.4804E-05 5.9021E-05 4.6104E-05 5.9733E-05 4.1207E-05

VEL X 2.3938E-05 2.6242E-05 2.1535E-06 2.7978E-05 2.5596E-05 2.3178E-05 1.9908E-05 2.5122E-05 2.8203E-05 2.5371E-05

VEL Y 2.9091E-05 2.4938E-05 2.1535E-06 2.7978E-05 2.5596E-05 2.3178E-05 1.9908E-05 2.5122E-05 2.0907E-05 1.7726E-05

VEL X 2.0216E-05 1.6222E-05 1.3904E-05 2.1525E-05 2.1525E-05 1.7227E-05 1.4068E-05 2.3323E-05 1.1109E-05 1.4242E-05

VEL Y 1.8746E-05 1.4872E-05 1.2053E-05 1.3525E-05 1.3525E-05 1.7197E-05 1.1090E-05 1.5193E-05 1.8015E-05 1.4242E-05

VEL X 1.1397E-05 8.3332E-06 5.9700E-06 1.1795E-05 8.5956E-06 6.1277E-06 1.2115E-05 8.7895E-06 6.2245E-06 6.8272E-06

VEL Y 1.0452E-05 8.9050E-06 7.7418E-06 9.7075E-06 8.3106E-06 7.3446E-06 8.7414E-06 7.5878E-06 6.2245E-06

LISTING D-6. Output Report File for Test Case Two. (Sheet 22 of 48)

SAMPLE PROBLEM: FLOW AROUND A HEATED CANNISTER

RESULTS FOR VELOCITY (M/YR) OF YEAR 1.000

ELEMENT		GSS PNT 1	GSS PNT 2	GSS PNT 3	GSS PNT 4	GSS PNT 5	GSS PNT 6	GSS PNT 7	GSS PNT 8	GSS PNT 9
97	VEL X	4.6252E-06	2.4282E-06	6.1918E-07	4.7355E-06	2.4897E-06	6.4047E-07	4.8268E-06	2.5342E-06	6.4617E-07
	VEL Y	7.0888E-06	6.5432E-06	6.2328E-06	6.7741E-06	6.2740E-06	6.0387E-06	6.3635E-06	5.9222E-06	5.7843E-06
98	VEL X	2.1731E-05	2.8024E-05	3.4844E-05	2.7338E-05	3.8595E-05	4.9907E-05	4.1027E-05	5.7544E-05	7.2645E-05
	VEL Y	7.8608E-05	7.7960E-05	7.5897E-05	9.1618E-05	8.7958E-05	8.2967E-05	1.1021E-04	1.0199E-04	9.2795E-05
99	VEL X	1.1580E-04	1.4714E-04	1.6394E-04	1.0930E-04	1.3960E-04	1.5668E-04	1.0270E-04	1.3215E-04	1.4973E-04
	VEL Y	8.8889E-05	6.3428E-05	2.6474E-05	9.1753E-05	6.7784E-05	3.3026E-05	9.6429E-05	7.4229E-05	4.1807E-05
100	VEL X	1.0035E-04	1.2975E-04	1.4445E-04	9.1743E-05	1.2068E-04	1.3587E-04	8.3047E-05	1.1183E-04	1.2792E-04
	VEL Y	1.0230E-04	7.9883E-05	4.4100E-05	1.0700E-04	8.5633E-05	5.1267E-05	1.1406E-04	9.3941E-05	6.0955E-05
101	VEL X	1.3573E-05	4.5304E-05	8.2562E-05	1.1242E-05	4.0843E-05	7.7220E-05	7.9140E-06	3.5681E-05	7.1490E-05
	VEL Y	1.2313E-04	1.2281E-04	1.1197E-04	1.2216E-04	1.2481E-04	1.1559E-04	1.2223E-04	1.2842E-04	1.2135E-04
102	VEL X	1.4891E-05	1.8445E-05	2.0919E-05	2.0354E-05	2.4883E-05	2.8052E-05	2.8873E-05	3.3855E-05	3.7362E-05
	VEL Y	5.1455E-05	4.8878E-05	4.5117E-05	5.7507E-05	5.2847E-05	4.6852E-05	6.5140E-05	5.7861E-05	4.9040E-05
103	VEL X	8.8747E-06	1.0692E-05	1.3239E-05	1.2950E-05	1.5479E-05	1.8754E-05	1.8890E-05	2.2643E-05	2.7156E-05
	VEL Y	5.3719E-05	5.2993E-05	5.2435E-05	6.1374E-05	6.0195E-05	5.9215E-05	7.1171E-05	6.9343E-05	6.7774E-05
104	VEL X	1.4303E-05	1.4592E-05	1.4831E-05	1.7640E-05	1.7387E-05	1.7178E-05	2.1212E-05	2.0399E-05	1.9726E-05
	VEL Y	2.9679E-05	2.7093E-05	2.4716E-05	2.9612E-05	2.6566E-05	2.3744E-05	2.9522E-05	2.5919E-05	2.2559E-05
105	VEL X	1.4624E-05	1.2625E-05	1.1275E-05	1.6866E-05	1.4079E-05	1.2198E-05	1.8918E-05	1.5382E-05	1.2994E-05
	VEL Y	2.2115E-05	1.8169E-05	1.5026E-05	2.1034E-05	1.7086E-05	1.4024E-05	1.9716E-05	1.5772E-05	1.2804E-05
106	VEL X	1.0961E-05	1.2497E-05	1.3693E-05	1.4334E-05	1.5881E-05	1.7087E-05	1.8726E-05	2.0164E-05	2.1288E-05
	VEL Y	3.5724E-05	3.3824E-05	3.1625E-05	3.7822E-05	3.5058E-05	3.1963E-05	4.0334E-05	3.6533E-05	3.2361E-05
107	VEL X	9.6864E-06	7.2090E-06	5.2982E-06	1.0431E-05	7.7112E-06	5.6136E-06	1.1056E-05	8.1101E-06	5.8380E-06
	VEL Y	1.3038E-05	1.0855E-05	9.1826E-06	1.2149E-05	1.0144E-05	8.6952E-06	1.1066E-05	9.2761E-06	8.1005E-06
108	VEL X	6.3568E-06	8.3440E-06	9.7130E-06	8.5242E-06	1.1142E-05	1.2953E-05	1.2109E-05	1.5100E-05	1.7178E-05
	VEL Y	3.9137E-05	3.8321E-05	3.7023E-05	4.3144E-05	4.1639E-05	3.9610E-05	4.7930E-05	4.5608E-05	4.2707E-05
109	VEL X	4.0973E-06	2.1539E-06	5.5362E-07	4.3274E-06	2.2797E-06	5.9364E-07	4.5274E-06	2.3784E-06	6.0895E-07
	VEL Y	8.2803E-06	7.4431E-06	6.9881E-06	7.8853E-06	7.1026E-06	6.7385E-06	7.4032E-06	6.6865E-06	6.4330E-06
110	VEL X	3.2623E-06	1.0139E-05	1.7854E-05	2.0976E-06	1.2978E-05	2.5234E-05	-2.0430E-06	1.4315E-05	3.2624E-05
	VEL Y	8.2974E-05	8.1907E-05	7.9479E-05	9.4333E-05	9.4826E-05	9.3002E-05	1.1127E-04	1.1354E-04	1.1289E-04
111	VEL X	2.5294E-05	5.5396E-05	8.6595E-05	2.0768E-05	5.1785E-05	8.5182E-05	1.5595E-05	4.7857E-05	8.3966E-05
	VEL Y	1.1501E-04	1.2056E-04	1.0554E-04	1.1606E-04	1.2272E-04	1.0749E-04	1.1804E-04	1.2613E-04	1.1095E-04
112	VEL X	1.4590E-06	4.2735E-06	7.8193E-06	2.0405E-06	5.7586E-06	1.0280E-05	2.7208E-06	7.9001E-06	1.3964E-05
	VEL Y	5.5039E-05	5.4649E-05	5.4131E-05	6.3395E-05	6.2828E-05	6.2043E-05	7.4245E-05	7.3415E-05	7.2223E-05

LISTING D-6. Output Report File for Test Case Two. (Sheet 23 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

RESULTS FOR VELOCITY (M/YR) OF YEAR 1.000

ELEMENT		QSS PNT 1	QSS PNT 2	QSS PNT 3	QSS PNT 4	QSS PNT 5	QSS PNT 6	QSS PNT 7	QSS PNT 8	QSS PNT 9
113	VEL X	8.6461E-06	8.6274E-06	7.2195E-06	9.5387E-06	7.9015E-06	1.1634E-05	5.1998E-06		
	VEL Y	4.6090E-05	4.4253E-05	4.4484E-05	4.9795E-05	4.9230E-05	4.9118E-05	4.0632E-05		
114	VEL X	3.9425E-06	6.0344E-06	3.0004E-06	3.3472E-06	1.8562E-06	5.5406E-06	5.8162E-06		
	VEL Y	4.2279E-05	4.3421E-05	3.9145E-05	4.4314E-05	4.0415E-05	4.7775E-05	3.8706E-05		
115	VEL X	1.7288E-06	3.3786E-06	2.4775E-06	-2.1834E-09	3.9770E-07	8.4117E-07	5.8561E-06		
	VEL Y	4.7344E-05	5.1102E-05	4.5498E-05	4.5793E-05	4.1888E-05	5.0954E-05	5.0193E-05		
116	VEL X	6.9528E-06	7.5573E-06	8.0561E-06	9.1107E-06	9.6851E-06	1.0160E-05	1.2035E-05	1.2509E-05	1.2902E-05
	VEL Y	2.7827E-05	2.6615E-05	2.5275E-05	2.8590E-05	2.6881E-05	2.5043E-05	2.9359E-05	2.7151E-05	2.4813E-05
117	VEL X	8.3531E-06	7.8666E-06	7.5379E-06	1.0572E-05	9.5640E-06	8.8827E-06	1.2964E-05	1.1400E-05	1.0344E-05
	VEL Y	2.3499E-05	2.0498E-05	1.7658E-05	2.3055E-05	1.9799E-05	1.6705E-05	2.2611E-05	1.9100E-05	1.5751E-05
118	VEL X	4.7115E-06	5.6760E-06	6.4223E-06	6.3348E-06	7.5924E-06	8.5678E-06	8.9161E-06	1.0349E-05	1.1462E-05
	VEL Y	3.0333E-05	2.9661E-05	2.8721E-05	3.2292E-05	3.1165E-05	2.9770E-05	3.4257E-05	3.2676E-05	3.0824E-05
119	VEL X	6.7492E-06	5.1522E-06	3.9204E-06	7.9402E-06	5.9938E-06	4.4925E-06	9.0539E-06	6.7682E-06	5.0051E-06
	VEL Y	1.5556E-05	1.2936E-05	1.0843E-05	1.4607E-05	1.2161E-05	1.0243E-05	1.3657E-05	1.1386E-05	9.6432E-06
120	VEL X	2.5958E-06	3.5049E-06	4.1236E-06	3.4549E-06	4.8041E-06	5.7268E-06	5.1381E-06	6.7717E-06	7.8943E-06
	VEL Y	3.1492E-05	3.1249E-05	3.0790E-05	3.4160E-05	3.3669E-05	3.2962E-05	3.6833E-05	3.6095E-05	3.5142E-05
121	VEL X	3.0374E-06	1.6001E-06	4.1658E-07	3.4801E-06	1.8371E-06	4.8421E-07	3.8928E-06	2.0470E-06	5.2715E-07
	VEL Y	9.6924E-06	8.5006E-06	7.8940E-06	9.1814E-06	8.0841E-06	7.5728E-06	8.6697E-06	7.6669E-06	7.2512E-06
122	VEL X	2.5491E-06	3.5683E-06	5.0387E-06	1.2501E-06	1.7246E-06	2.4482E-06	6.3933E-07	8.8238E-07	1.2994E-06
	VEL Y	3.1641E-05	3.4415E-05	3.7196E-05	3.1816E-05	3.4689E-05	3.7573E-05	3.1927E-05	3.4896E-05	3.7876E-05
123	VEL X	3.0021E-06	3.3606E-06	3.6555E-06	4.2171E-06	4.6919E-06	5.0829E-06	5.7571E-06	6.3186E-06	6.7815E-06
	VEL Y	2.6443E-05	2.5681E-05	2.4751E-05	2.6964E-05	2.5990E-05	2.4849E-05	2.7487E-05	2.6302E-05	2.4947E-05
124	VEL X	3.8651E-06	3.8481E-06	3.8367E-06	5.3852E-06	5.2482E-06	5.1556E-06	7.0480E-06	6.7632E-06	6.5708E-06
	VEL Y	2.3599E-05	2.1357E-05	1.8802E-05	2.3574E-05	2.1122E-05	1.8358E-05	2.3549E-05	2.0888E-05	1.7913E-05
125	VEL X	1.9484E-06	2.4011E-06	2.7495E-06	2.7759E-06	3.4144E-06	3.9069E-06	3.8875E-06	4.6763E-06	5.2860E-06
	VEL Y	2.7892E-05	2.7495E-05	2.6941E-05	2.8785E-05	2.8253E-05	2.7564E-05	2.9682E-05	2.9015E-05	2.8191E-05
126	VEL X	3.5490E-06	2.7612E-06	2.1535E-06	4.7691E-06	3.6795E-06	2.8391E-06	5.9627E-06	4.5748E-06	3.5043E-06
	VEL Y	1.6859E-05	1.4174E-05	1.1877E-05	1.6378E-05	1.3750E-05	1.1510E-05	1.5898E-05	1.3325E-05	1.1142E-05
127	VEL X	1.0635E-06	1.4529E-06	1.7148E-06	1.5145E-06	2.0773E-06	2.4562E-06	2.1784E-06	2.8698E-06	3.3391E-06
	VEL Y	2.8511E-05	2.8364E-05	2.8125E-05	2.9589E-05	2.9379E-05	2.9078E-05	3.0670E-05	3.0397E-05	3.0034E-05
128	VEL X	1.6809E-06	8.8590E-07	2.3124E-07	2.2189E-06	1.1726E-06	3.1098E-07	2.7370E-06	1.4413E-06	3.7435E-07
	VEL Y	1.0609E-05	9.1979E-06	8.4980E-06	1.0281E-05	8.9313E-06	8.2943E-06	9.9523E-06	8.6644E-06	8.0903E-06

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LISTING D-6. Output Report File for Test Case Two. (Sheet 24 of 48)

SAMPLE PROBLEM. FLOW AROUND A HEATED CANNISTER

RESULTS FOR VELOCITY (M/YR) OF YEAR 1.000

ELEMENT		GSS PNT 1	GSS PNT 2	GSS PNT 3	GSS PNT 4	GSS PNT 5	GSS PNT 6	GSS PNT 7	GSS PNT 8	GSS PNT 9
129	VEL X	1.0511E-06	1.5028E-06	2.0594E-06	5.1729E-07	7.4142E-07	1.0214E-06	2.4760E-07	3.6713E-07	5.2513E-07
	VEL Y	2.8593E-05	2.9697E-05	3.0805E-05	2.8688E-05	2.9815E-05	3.0947E-05	2.8755E-05	2.9903E-05	3.1056E-05
130	VEL X	2.6755E-07	3.0456E-07	3.3492E-07	1.2409E-06	1.4010E-06	1.5324E-06	2.2985E-06	2.5747E-06	2.8017E-06
	VEL Y	2.5975E-05	2.5299E-05	2.4467E-05	2.6140E-05	2.5409E-05	2.4521E-05	2.6307E-05	2.5520E-05	2.4576E-05
131	VEL X	3.6318E-07	3.6762E-07	3.7062E-07	1.6416E-06	1.6554E-06	1.6648E-06	2.9671E-06	2.9812E-06	2.9907E-06
	VEL Y	2.3608E-05	2.1580E-05	1.9095E-05	2.3625E-05	2.1526E-05	1.8969E-05	2.3643E-05	2.1472E-05	1.8843E-05
132	VEL X	1.6998E-07	2.1522E-07	2.4986E-07	7.9598E-07	9.9150E-07	1.1415E-06	1.4864E-06	1.8243E-06	2.0841E-06
	VEL Y	2.7128E-05	2.6793E-05	2.6339E-05	2.7382E-05	2.7016E-05	2.6526E-05	2.7638E-05	2.7240E-05	2.6718E-05
133	VEL X	3.5609E-07	2.7818E-07	2.1809E-07	1.5758E-06	1.2307E-06	9.6447E-07	2.7892E-06	2.1777E-06	1.7060E-06
	VEL Y	1.7347E-05	1.4653E-05	1.2251E-05	1.7204E-05	1.4520E-05	1.2129E-05	1.7061E-05	1.4387E-05	1.2007E-05
134	VEL X	9.0831E-08	1.2987E-07	1.5577E-07	4.3130E-07	5.9872E-07	7.1038E-07	8.1600E-07	1.1025E-06	1.2945E-06
	VEL Y	2.7604E-05	2.7481E-05	2.7289E-05	2.7899E-05	2.7762E-05	2.7557E-05	2.8196E-05	2.8045E-05	2.7826E-05
135	VEL X	1.7244E-07	9.1511E-08	2.4870E-08	7.6041E-07	4.0184E-07	1.0657E-07	1.3413E-06	7.0574E-07	1.8241E-07
	VEL Y	1.0976E-05	9.4678E-06	8.7450E-06	1.0863E-05	9.3760E-06	8.6751E-06	1.0750E-05	9.2941E-06	8.6052E-06
136	VEL X	9.2514E-08	4.2829E-07	7.9198E-07	4.6761E-08	2.1412E-07	3.9162E-07	2.2023E-08	1.0127E-07	1.8616E-07
	VEL Y	2.7662E-05	2.7963E-05	2.8266E-05	2.7742E-05	2.8048E-05	2.8356E-05	2.7795E-05	2.8105E-05	2.8416E-05

LISTING D-6. Output Report File for Test Case Two. (Sheet 25 of 48)

SAMPLE PROBLEM. FLOW AROUND A HEATED CANNISTER

RESULTS ON YEAR 5.000

NODE	T(C)	H(M)	NODE	T(C)	H(M)	NODE	T(C)	H(M)
1	50.00	*	1.200	*		51	53.67	1.160
2	50.00	*	1.200	*		52	53.95	1.159
3	50.00	*	1.200	*		53	51.81	1.170
4	50.00	*	1.200	*		54	52.37	1.160
5	50.00	*	1.200	*		55	53.08	1.160
6	50.00	*	1.200	*		56	50.89	1.170
7	50.00	*	1.200	*		57	51.16	1.160
8	50.00	*	1.200	*		58	51.70	1.160
9	50.00	*	1.200	*		59	50.53	1.170
10	50.00	*	1.200	*		60	50.69	1.160
11	50.00	*	1.200	*		61	50.82	1.160
12	50.00	*	1.200	*		62	55.97	1.149
13	50.00	*	1.200	*		63	57.58	1.140
14	50.00	*	1.200	*		64	57.65	1.140
15	50.00	*	1.200	*		65	57.70	1.140
16	51.07	1.189		66	56.04	1.149		
17	52.17	1.179		67	55.78	1.150		
18	52.18	1.179		68	57.28	1.140		
19	52.19	1.179		69	57.47	1.140		
20	51.08	1.189		70	55.35	1.150		
21	51.05	1.189		71	56.62	1.141		
22	52.13	1.179		72	57.00	1.141		
23	52.14	1.179		73	54.63	1.150		
24	51.00	1.189		74	55.59	1.141		
25	52.02	1.179		75	56.15	1.141		
26	52.08	1.179		76	52.91	1.151		
27	50.90	1.190		77	53.39	1.141		
28	51.81	1.179		78	54.53	1.141		
29	51.92	1.179		79	51.40	1.151		
30	50.61	1.190		80	51.61	1.141		
31	51.21	1.180		81	52.38	1.141		
32	51.55	1.179		82	50.83	1.151		
33	50.31	1.190		83	50.95	1.141		
34	50.61	1.180		84	51.13	1.141		
35	50.88	1.180		85	58.92	1.134		
36	50.18	1.190		86	60.54	1.128		
37	50.36	1.180		87	59.02	1.134		
38	50.43	1.180		88	59.01	1.133		
39	53.33	1.169		89	60.54	1.127		
40	54.58	1.159		90	60.52	1.128		
41	54.60	1.159		91	58.57	1.134		
42	54.62	1.159		92	59.86	1.128		
43	53.36	1.169		93	60.27	1.128		
44	53.25	1.169		94	60.57	1.128		
45	54.46	1.159		95	60.60	1.128		
46	54.53	1.159		96	59.11	1.134		
47	53.07	1.169		97	57.64	1.134		
48	54.17	1.159		98	58.56	1.129		
49	54.34	1.159		99	59.28	1.128		
50	52.73	1.169	100	56.31	1.135			

LISTING D-6. Output Report File for Test Case Two. (Sheet 26 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

RESULTS ON YEAR 5.000

NODE	T(C)	H(M)	NODE	T(C)	H(M)	NODE	T(C)	H(M)
151	62.25	1.116	201	68.51	1.112	251	67.61	1.118
152	57.90	1.117	202	69.08	1.113	252	68.07	1.118
153	58.03	1.115	203	69.03	1.112	253	68.18	1.117
154	59.30	1.116	204	69.09	1.114	254	62.24	1.110
155	54.30	1.115	205	69.03	1.113	255	68.56	1.118
156	54.34	1.113	206	68.56	1.114	256	69.09	1.118
157	56.06	1.114	207	67.36	1.116	257	69.21	1.117
158	51.97	1.114	208	67.25	1.115	258	69.76	1.119
159	51.99	1.111	209	63.89	1.114	259	70.31	1.119
160	52.97	1.112	210	63.95	1.114	260	70.71	1.117
161	51.16	1.113	211	65.67	1.115	261	59.30	1.104
162	51.17	1.110	212	68.30	1.116	262	60.72	1.105
163	51.38	1.110	213	68.18	1.115	263	60.71	1.107
164	68.28	1.111	214	67.82	1.116	264	62.25	1.109
165	67.80	1.111	215	60.78	1.113	265	63.87	1.112
166	67.59	1.111	216	60.81	1.111	266	63.82	1.112
167	68.05	1.111	217	62.32	1.112	267	57.90	1.100
168	68.16	1.111	218	69.30	1.116	268	57.69	1.096
169	67.50	1.112	219	69.21	1.115	269	58.81	1.098
170	67.98	1.112	220	68.79	1.116	270	59.99	1.100
171	67.98	1.112	221	59.42	1.110	271	60.43	1.104
172	67.17	1.114	222	59.34	1.108	272	54.30	1.095
173	67.11	1.113	223	60.73	1.108	273	54.23	1.092
174	63.82	1.115	224	60.78	1.110	274	55.87	1.094
175	63.84	1.115	225	58.11	1.105	275	51.97	1.092
176	65.52	1.115	226	58.03	1.103	276	51.95	1.088
177	68.07	1.114	227	59.23	1.105	277	52.91	1.090
178	67.99	1.113	228	54.37	1.101	278	51.16	1.091
179	67.61	1.114	229	54.34	1.098	279	51.15	1.087
180	60.71	1.115	230	56.06	1.100	280	51.35	1.087
181	60.73	1.114	231	52.00	1.098	281	71.41	1.116
182	62.24	1.115	232	51.99	1.095	282	71.29	1.115
183	59.23	1.114	233	52.97	1.096	283	71.29	1.116
184	58.17	1.109	234	51.18	1.097	284	70.71	1.119
185	59.34	1.112	235	51.17	1.094	285	70.88	1.119
186	58.11	1.113	236	51.38	1.094	286	71.29	1.117
187	54.37	1.110	237	70.88	1.114	287	65.54	1.116
188	54.39	1.105	238	70.22	1.113	288	67.05	1.121
189	56.14	1.107	239	69.75	1.113	289	67.10	1.120
190	52.00	1.108	240	70.31	1.114	290	67.50	1.120
191	52.01	1.103	241	70.71	1.114	291	67.98	1.120
192	53.00	1.104	242	69.76	1.114	292	67.99	1.119
193	51.18	1.107	243	70.89	1.116	293	68.50	1.120
194	51.18	1.102	244	70.71	1.115	294	69.08	1.120
195	51.39	1.102	245	70.23	1.116	295	69.03	1.119
196	69.29	1.111	246	63.89	1.113	296	69.03	1.120
197	68.77	1.111	247	63.84	1.112	297	69.08	1.121
198	68.55	1.111	248	65.52	1.115	298	69.75	1.120
199	69.08	1.112	249	67.17	1.119	299	69.20	1.121
200	69.20	1.111	250	67.25	1.117	300	69.29	1.121

LISTING D-6. Output Report File for Test Case Two. (Sheet 27 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

RESULTS ON YEAR 5.000

NODE	T(C)	H(M)	NODE	T(C)	H(M)	NODE	T(C)	H(M)
301	70.22	1.120	350	54.53	1.069	399	54.60	1.052
302	61.17	1.103	351	57.00	1.075	400	52.73	1.037
303	62.25	1.105	352	57.28	1.076	401	51.81	1.025
304	63.21	1.109	353	58.57	1.085	402	51.92	1.026
305	63.18	1.108	354	51.74	1.071	403	52.02	1.026
306	63.82	1.109	355	51.61	1.064	404	53.07	1.038
307	65.52	1.116	356	52.38	1.065	405	51.81	1.035
308	57.35	1.092	357	57.47	1.076	406	51.21	1.024
309	56.89	1.086	358	57.58	1.076	407	51.55	1.024
310	57.75	1.088	359	59.01	1.086	408	52.08	1.026
311	58.56	1.090	360	51.03	1.070	409	52.13	1.026
312	59.36	1.096	361	50.95	1.062	410	53.25	1.039
313	54.11	1.087	362	51.13	1.063	411	50.89	1.033
314	53.94	1.081	363	67.34	1.122	412	50.61	1.022
315	55.40	1.084	364	67.23	1.122	413	50.88	1.023
316	59.28	1.091	365	63.81	1.109	414	52.16	1.026
317	59.86	1.093	366	63.87	1.109	415	52.17	1.026
318	61.11	1.099	367	65.62	1.116	416	53.33	1.039
319	51.90	1.084	368	67.80	1.122	417	50.53	1.032
320	51.84	1.078	369	60.57	1.094	418	50.36	1.021
321	52.73	1.079	370	60.60	1.094	419	50.43	1.021
322	51.12	1.082	371	62.19	1.102	420	52.19	1.026
323	51.08	1.077	372	58.92	1.085	421	53.36	1.039
324	51.28	1.077	373	57.70	1.077	422	52.18	1.026
325	67.15	1.122	374	59.02	1.085	423	50.90	1.013
326	67.09	1.121	375	57.65	1.077	424	50.00	*
327	63.76	1.109	376	59.11	1.086	425	50.00	*
328	63.77	1.109	377	54.63	1.060	426	50.00	*
329	65.47	1.115	378	53.67	1.049	427	51.00	1.013
330	68.05	1.121	379	53.95	1.050	428	50.61	1.012
331	67.98	1.121	380	54.17	1.050	429	50.00	*
332	67.59	1.121	381	55.35	1.062	430	50.00	*
333	68.55	1.121	382	52.91	1.057	431	50.00	*
334	68.16	1.121	383	52.37	1.046	432	50.00	*
335	68.27	1.121	384	53.08	1.048	433	51.05	1.013
336	68.77	1.121	385	54.34	1.051	434	50.31	1.011
337	60.27	1.094	386	54.46	1.051	435	50.00	*
338	60.54	1.094	387	55.78	1.063	436	50.00	*
339	62.15	1.102	388	51.40	1.053	437	50.00	*
340	60.52	1.094	389	51.16	1.043	438	50.00	*
341	60.54	1.094	390	51.70	1.044	439	51.07	1.013
342	62.11	1.102	391	54.53	1.051	440	50.18	1.011
343	56.31	1.080	392	54.58	1.052	441	50.00	*
344	55.59	1.072	393	55.97	1.064	442	50.00	*
345	56.15	1.073	394	50.83	1.052	443	50.00	*
346	56.62	1.074	395	50.69	1.042	444	51.08	1.013
347	57.64	1.082	396	50.82	1.042	445	50.00	*
348	53.71	1.075	397	54.62	1.052			
349	53.39	1.067	398	56.04	1.064			

ITERATION NUMBER 1. MAX CHANGE (TEMP) = 3.5411E-05, MAX REL CORRECTION = 1.9037E-03
 ITERATION NUMBER 1. MAX CHANGE (HEAD) = 2.3423E-02, MAX REL CORRECTION = 3.4447E-02

LISTING D-6. Output Report File for Test Case Two. (Sheet 28 of 48)

RESULTS FOR VELOCITY (M/YR) OF YEAR 5.000

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

ELEMENT

QSS PNT 1 QSS PNT 2 QSS PNT 3 QSS PNT 4 QSS PNT 5 QSS PNT 6 QSS PNT 7 QSS PNT 8 QSS PNT 9

1	VEL X	-4.234E-09 -8.5105E-09 -1.6843E-09 -2.3803E-09 -4.7429E-09 -9.2267E-09 -5.3783E-10 -1.0511E-09 -2.0003E-09	QSS PNT 2 QSS PNT 3 QSS PNT 4 QSS PNT 5 QSS PNT 6 QSS PNT 7 QSS PNT 8 QSS PNT 9
2	VEL Y	-2.7724E-08 -1.5295E-08 -3.3697E-09 -2.3727E-09 -1.2941E-08 -2.8491E-09 -1.7764E-08 -9.5368E-09 -2.0645E-09	5.0783E-06 5.0679E-06 5.0590E-06 5.0840E-06 5.0727E-06 5.0632E-06 5.0877E-06 5.0760E-06 5.0660E-06
3	VEL X	-4.2535E-08 -2.3744E-08 -5.3011E-09 -3.7657E-08 -2.0981E-08 -4.6751E-09 -3.1312E-08 -1.7380E-08 -3.8573E-09	5.0497E-06 5.0416E-06 5.0349E-06 5.0619E-06 5.0526E-06 5.0449E-06 5.0711E-06 5.0609E-06 5.0524E-06
4	VEL Y	-5.3494E-08 -2.9391E-08 -6.4454E-08 -9.5025E-08 -12.7518E-08 -4.0223E-09 -6.6316E-08 -2.5238E-08 -5.0624E-09	4.9940E-06 4.9920E-06 4.9907E-06 5.0158E-06 5.0110E-06 5.0073E-06 5.0340E-06 5.0269E-06 5.0211E-06
5	VEL X	-4.0190E-08 -2.3539E-08 -5.5066E-08 -4.3875E-08 -2.5787E-08 -4.0524E-09 -4.9329E-08 -2.9116E-08 -6.8603E-09	4.8812E-06 4.8821E-06 4.8833E-06 4.9232E-06 4.9226E-06 4.9226E-06 4.9650E-06 4.9590E-06 4.9585E-06
6	VEL Y	-1.1417E-08 -7.4331E-09 -1.8994E-09 -2.0111E-08 -1.2453E-08 -4.7985E-06 4.0622E-09 -3.1383E-08 -1.8978E-08 -5.6933E-09	4.7763E-06 4.7766E-06 4.7765E-06 4.7766E-06 4.7765E-06 4.7766E-06 4.8308E-06 4.8305E-06 4.8308E-06
7	VEL X	1.9071E-09 7.6658E-10 1.0521E-10 -3.7863E-09 -2.4729E-10 -1.0701E-08 -6.4071E-09 -1.5314E-09	4.7313E-06 4.7319E-06 4.7313E-06 4.7339E-06 4.7343E-06 4.7343E-06 4.7345E-06 4.7345E-06 4.7345E-06
8	VEL Y	-8.8904E-09 -1.8579E-08 -3.8844E-08 -6.5479E-09 -1.3932E-08 -2.9013E-08 -5.1768E-09 -1.0680E-08 -2.1608E-08	5.1771E-06 5.1745E-06 5.1711E-06 5.1402E-06 5.1385E-06 5.1359E-06 5.1078E-06 5.1068E-06 5.1049E-06
9	VEL X	-5.9459E-08 -4.5264E-08 -3.4920E-08 -5.0930E-08 -5.1810E-08 -3.8454E-08 -2.9677E-08 -4.0542E-08 -2.8373E-08	5.1484E-06 5.1188E-06 5.0930E-06 5.1572E-06 5.1251E-06 5.0971E-06 5.1639E-06 5.1296E-06 5.0995E-06
10	VEL Y	-8.6262E-08 -6.7499E-08 -5.3173E-08 -7.8239E-08 -6.0138E-08 -4.7024E-08 -6.7859E-08 -5.0535E-08 -3.9035E-08	5.0986E-06 5.0794E-06 5.0631E-06 5.0116E-06 5.0926E-06 5.0723E-06 5.1308E-06 5.1031E-06 5.0791E-06
11	VEL X	-9.3081E-08 -7.6448E-08 -6.5092E-08 -9.1341E-08 -7.3515E-08 -6.1459E-08 -8.9233E-08 -6.0594E-08 -3.9035E-08	5.0122E-06 5.0147E-06 5.0137E-06 5.0417E-06 5.0324E-06 5.0251E-06 5.0645E-06 5.0486E-06 5.0353E-06
12	VEL Y	-4.8481E-08 -4.8568E-08 -4.6818E-08 -6.2658E-08 -5.6616E-08 -4.9180E-08 -5.2357E-08 -8.3704E-08 -7.3489E-08	4.8925E-06 4.8960E-06 4.8992E-06 4.9180E-06 4.9194E-06 4.9214E-06 4.9479E-06 4.9479E-06 4.9490E-06
13	VEL X	-4.6400E-09 -9.4072E-09 -1.2090E-08 -1.6881E-08 -2.0790E-08 -2.2344E-08 -3.2752E-08 -4.8035E-08 -3.5547E-08	4.7905E-06 4.7930E-06 4.7956E-06 4.7956E-06 4.7956E-06 4.7956E-06 4.7972E-06 4.8073E-06 4.8107E-06
14	VEL Y	-3.3911E-09 2.6117E-09 2.3344E-09 -4.5221E-10 -2.4012E-09 -3.7997E-09 -5.1195E-09 -1.1249E-09	4.7371E-06 4.7336E-06 4.7356E-06 4.7356E-06 4.7356E-06 4.7356E-06 4.7344E-06 4.7344E-06 4.7344E-06
15	VEL X	-2.7745E-08 -4.5665E-08 -8.6074E-08 -1.1688E-08 -3.0411E-08 -6.0017E-08 -5.2561E-08 -5.2033E-08 -5.8739E-08	5.3511E-06 5.3418E-06 5.3315E-06 5.2720E-06 5.25920E-06 5.1825E-06 5.3133E-06 5.2451E-06 5.1863E-06
16	VEL Y	-1.3417E-07 -9.3568E-08 -7.0355E-08 -1.1891E-07 -5.9475E-08 -6.6431E-08 -5.2005E-08 -5.8739E-08 -4.5892E-08	5.2653E-06 5.2158E-06 5.1745E-06 5.1745E-06 5.1745E-06 5.1745E-06 5.1825E-06 5.2451E-06 5.1863E-06

LISTING D-6. Output Report File for Test Case Two. (Sheet 29 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

RESULTS FOR VELOCITY (M/YR) OF YEAR 5.000

ELEMENT		GSS PNT 1	GSS PNT 2	GSS PNT 3	GSS PNT 4	GSS PNT 5	GSS PNT 6	GSS PNT 7	GSS PNT 8	GSS PNT 9
17	VEL X	-1.5532E-07	-1.1B62E-07	-9.8635E-08	-1.5113E-07	-1.1125E-07	-9.0152E-08	-1.4574E-07	-1.0176E-07	-7.9190E-08
	VEL Y	5.1434E-06	5.1292E-06	5.1201E-06	5.1890E-06	5.1564E-06	5.1340E-06	5.2227E-06	5.1803E-06	5.1454E-06
18	VEL X	-1.0541E-07	-1.0056E-07	-1.0101E-07	-1.2321E-07	-1.0968E-07	-1.0195E-07	-1.4473E-07	-1.2071E-07	-1.0309E-07
	VEL Y	5.0124E-06	5.0244E-06	5.0378E-06	5.0427E-06	5.0451E-06	5.0502E-06	5.0766E-06	5.0695E-06	5.0667E-06
19	VEL X	-2.3752E-09	-2.6635E-08	-4.5026E-08	-3.3447E-08	-5.1736E-08	-6.3022E-08	-7.9443E-08	-8.8895E-08	-8.9661E-08
	VEL Y	4.8990E-06	4.9038E-06	4.9075E-06	4.8934E-06	4.9030E-06	4.9123E-06	4.9053E-06	4.9190E-06	4.9332E-06
20	VEL X	2.3762E-08	1.0562E-08	-2.1749E-10	1.8473E-08	1.8765E-09	-1.1987E-08	1.1615E-08	-9.3845E-09	-2.7247E-08
	VEL Y	4.8122E-06	4.8085E-06	4.8040E-06	4.7943E-06	4.7946E-06	4.7937E-06	4.7791E-06	4.7818E-06	4.7832E-06
21	VEL X	5.7386E-09	4.6673E-09	3.9026E-09	1.0948E-08	6.0483E-09	1.4847E-09	1.7275E-08	7.7254E-09	-1.4517E-09
	VEL Y	4.7505E-06	4.7460E-06	4.7409E-06	4.7460E-06	4.7419E-06	4.7372E-06	4.7364E-06	4.7318E-06	4.7265E-06
22	VEL X	-8.8428E-08	-1.3464E-07	-8.2045E-08	-5.9445E-08	-4.2334E-08	-1.0852E-07	-1.3759E-07		
	VEL Y	5.4370E-06	5.4578E-06	5.4891E-06	5.3690E-06	5.4043E-06	5.3509E-06	5.5688E-06		
23	VEL X	-2.1164E-07	-2.0411E-07	-2.6756E-07	-1.6152E-07	-2.1157E-07	-1.0338E-07	-3.2300E-07		
	VEL Y	5.5634E-06	5.5166E-06	5.6445E-06	5.5341E-06	5.6493E-06	5.4421E-06	5.6118E-06		
24	VEL X	-3.5032E-07	-2.4269E-07	-1.6958E-07	-3.2890E-07	-2.1987E-07	-1.5145E-07	-2.9810E-07	-1.8688E-07	-1.2514E-07
	VEL Y	5.3559E-06	5.3340E-06	5.3064E-06	5.4524E-06	5.3972E-06	5.3423E-06	5.5336E-06	5.4472E-06	5.3669E-06
25	VEL X	-4.4731E-08	-8.6889E-08	9.2467E-09	-6.6201E-08	1.2843E-08	-1.5981E-07	-1.6038E-08		
	VEL Y	5.6240E-06	5.7122E-06	5.5889E-06	5.5777E-06	5.4911E-06	5.6923E-06	5.7081E-06		
26	VEL X	-2.4184E-07	-2.0223E-07	-1.7863E-07	-2.8323E-07	-2.2305E-07	-1.8074E-07	-3.3626E-07	-2.4979E-07	-1.8346E-07
	VEL Y	5.0760E-06	5.1235E-06	5.1526E-06	5.1585E-06	5.1804E-06	5.1886E-06	5.2489E-06	5.2448E-06	5.2319E-06
27	VEL X	-4.5524E-08	-8.0289E-08	-1.0527E-07	-1.0922E-07	-1.2590E-07	-1.3192E-07	-1.8604E-07	-1.8098E-07	-1.6414E-07
	VEL Y	4.9434E-06	4.9830E-06	5.0069E-06	4.9445E-06	4.9921E-06	5.0222E-06	4.9677E-06	5.0207E-06	5.0547E-06
28	VEL X	8.0492E-08	4.5367E-08	1.4210E-08	4.8352E-08	1.2286E-08	-1.9058E-08	7.6637E-10	-3.6691E-08	-6.8307E-08
	VEL Y	4.9130E-06	4.9143E-06	4.9109E-06	4.8575E-06	4.8762E-06	4.8856E-06	4.8217E-06	4.8541E-06	4.8731E-06
29	VEL X	5.6653E-08	4.4897E-08	3.2191E-08	6.6060E-08	4.8414E-08	2.9686E-08	7.8261E-08	5.2979E-08	2.6441E-08
	VEL Y	4.8382E-06	4.8326E-06	4.8262E-06	4.8102E-06	4.8047E-06	4.7976E-06	4.7740E-06	4.7693E-06	4.7619E-06
30	VEL X	8.1071E-09	7.4845E-09	6.4934E-09	2.3493E-08	1.8954E-08	1.4009E-08	4.2183E-08	3.2887E-08	2.3137E-08
	VEL Y	4.7666E-06	4.7613E-06	4.7560E-06	4.7614E-06	4.7550E-06	4.7486E-06	4.7445E-06	4.7386E-06	4.7323E-06
31	VEL X	-5.3513E-07	-3.3758E-07	-2.0603E-07	-3.3863E-07	-2.0075E-07	-1.1244E-07	-1.6365E-07	-8.4832E-08	-3.6844E-08
	VEL Y	6.4256E-06	6.0690E-06	5.7763E-06	6.5101E-06	6.1223E-06	5.8071E-06	6.5804E-06	6.1653E-06	5.8304E-06
32	VEL X	-1.0226E-06	-5.7169E-07	-3.3638E-07	-9.4531E-07	-5.0554E-07	-2.7610E-07	-8.5551E-07	-4.4427E-07	-2.3172E-07
	VEL Y	5.9923E-06	5.8393E-06	5.7015E-06	6.1521E-06	5.9233E-06	5.7252E-06	6.3331E-06	6.0187E-06	5.7546E-06

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SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER
RESULTS FOR VEL001 VELOCITY (M/VR) OF YEAR 5.000

LISTING D-6. Output Report File for Test Case Two. (Sheet 30 of 48)

ELEMENT	VEL X	VEL Y	VEL Z
33	VEL X	VEL Y	VEL Z
34	VEL X	VEL Y	VEL Z
35	VEL X	VEL Y	VEL Z
36	VEL X	VEL Y	VEL Z
37	VEL X	VEL Y	VEL Z
38	VEL X	VEL Y	VEL Z
39	VEL X	VEL Y	VEL Z
40	VEL X	VEL Y	VEL Z
41	VEL X	VEL Y	VEL Z
42	VEL X	VEL Y	VEL Z
43	VEL X	VEL Y	VEL Z
44	VEL X	VEL Y	VEL Z
45	VEL X	VEL Y	VEL Z
46	VEL X	VEL Y	VEL Z
47	VEL X	VEL Y	VEL Z
48	VEL X	VEL Y	VEL Z

LISTING D-6. Output Report File for Test Case Two. (Sheet 31 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

RESULTS FOR VELOCITY (M/YR) OF YEAR 5.000

ELEMENT		GSS PNT 1	GSS PNT 2	GSS PNT 3	GSS PNT 4	GSS PNT 5	GSS PNT 6	GSS PNT 7	GSS PNT 8	GSS PNT 9
49	VEL X	-7.8294E-08	-5.3398E-07	-9.0414E-07	-8.8271E-07	-1.5809E-06	-2.1457E-06	-2.0666E-06	-3.0870E-06	-3.8976E-06
	VEL Y	3.2753E-06	3.4097E-06	3.6637E-06	2.3082E-06	2.7683E-06	3.4626E-06	1.1785E-06	2.1721E-06	3.5269E-06
50	VEL X	-5.9961E-05	-7.7241E-05	-8.7454E-05	-5.8643E-05	-7.3644E-05	-8.2370E-05	-5.7321E-05	-7.0237E-05	-7.7821E-05
	VEL Y	-1.3788E-04	-1.1302E-04	-8.2375E-05	-1.2075E-04	-9.9027E-05	-7.0209E-05	-1.0175E-04	-8.3278E-05	-5.6350E-05
51	VEL X	4.8985E-07	3.8473E-07	2.9180E-07	3.4222E-07	1.4801E-07	-2.3223E-08	1.4543E-07	-1.5981E-07	-4.2522E-07
	VEL Y	4.4846E-06	4.4671E-06	4.4581E-06	4.1276E-06	4.1199E-06	4.1454E-06	3.5706E-06	3.6016E-06	3.7055E-06
52	VEL X	3.5679E-07	3.6556E-07	3.2257E-07	3.8473E-07	3.5045E-07	4.2325E-07	3.0039E-07		
	VEL Y	4.5982E-06	4.4388E-06	4.7247E-06	4.6454E-06	4.8797E-06	4.4604E-06	4.4769E-06		
53	VEL X	4.5705E-07	4.0094E-07	4.5878E-07	5.1859E-07	5.5718E-07	4.7807E-07	3.5585E-07		
	VEL Y	4.7788E-06	4.6545E-06	4.8720E-06	4.7873E-06	4.8910E-06	4.6328E-06	4.7903E-06		
54	VEL X	2.8851E-07	2.5641E-07	2.3860E-07	3.7602E-07	3.2361E-07	2.8796E-07	5.0557E-07	4.2309E-07	3.6067E-07
	VEL Y	5.0225E-06	5.0080E-06	4.9779E-06	4.9216E-06	4.9180E-06	4.9111E-06	4.7881E-06	4.7739E-06	4.7442E-06
55	VEL X	1.1858E-07	1.0998E-07	1.0445E-07	1.7218E-07	1.5798E-07	1.4713E-07	2.4168E-07	2.2020E-07	2.0237E-07
	VEL Y	4.9051E-06	4.8987E-06	4.8860E-06	4.8759E-06	4.8694E-06	4.8562E-06	4.8378E-06	4.8219E-06	4.7891E-06
56	VEL X	1.1609E-08	1.0785E-08	1.0713E-08	4.7666E-08	4.4455E-08	4.2058E-08	9.1457E-08	8.5344E-08	8.0080E-08
	VEL Y	4.8078E-06	4.8028E-06	4.7935E-06	4.8003E-06	4.7974E-06	4.7921E-06	4.7884E-06	4.7825E-06	4.7711E-06
57	VEL X	-4.6336E-05	-4.9931E-05	-5.3675E-05	-2.4612E-05	-2.7318E-05	-2.9855E-05	-4.6003E-06	-7.8991E-06	-8.7365E-06
	VEL Y	3.2717E-05	2.4091E-05	1.7444E-05	4.4740E-05	3.6581E-05	2.9938E-05	4.6872E-05	4.0382E-05	3.4917E-05
58	VEL X	-6.3635E-05	-7.0358E-05	-7.7254E-05	-6.0458E-05	-6.7499E-05	-7.4492E-05	-4.8681E-05	-5.5149E-05	-6.1382E-05
	VEL Y	-8.2392E-06	-2.3043E-05	-3.5170E-05	1.0341E-05	-1.5736E-06	-1.0934E-05	2.5145E-05	1.5514E-05	8.1977E-06
59	VEL X	-5.3720E-05	-6.8889E-05	-7.5078E-05	-5.0430E-05	-6.2705E-05	-6.7300E-05	-4.7076E-05	-5.6642E-05	-6.0086E-05
	VEL Y	-9.2981E-05	-7.4620E-05	-4.9027E-05	-7.2855E-05	-5.7682E-05	-3.4367E-05	-4.9990E-05	-3.8226E-05	-1.7468E-05
60	VEL X	1.3096E-06	7.4554E-07	2.1522E-07	1.3985E-06	4.5617E-07	-4.1687E-07	1.5265E-06	1.0744E-08	-1.3622E-06
	VEL Y	3.1187E-06	3.0940E-06	3.1862E-06	2.0119E-06	1.9588E-06	2.1363E-06	4.2998E-07	3.8880E-07	7.8112E-07
61	VEL X	-2.5433E-06	-2.1942E-05	-4.6063E-05	-2.5337E-06	-2.1743E-05	-4.5953E-05	-2.5305E-06	-2.1598E-05	-4.6014E-05
	VEL Y	-1.7946E-04	-1.6787E-04	-1.4529E-04	-1.5811E-04	-1.4902E-04	-1.2915E-04	-1.3585E-04	-1.2924E-04	-1.1215E-04
62	VEL X	8.6459E-07	6.9446E-07	5.5592E-07	9.9860E-07	7.1092E-07	4.6495E-07	1.1715E-06	7.2713E-07	3.4047E-07
	VEL Y	4.5361E-06	4.4992E-06	4.4690E-06	4.1036E-06	4.0824E-06	4.0962E-06	3.4528E-06	3.4402E-06	3.5050E-06
63	VEL X	-4.6043E-06	-2.5782E-05	-4.4325E-05	-4.3890E-06	-2.4609E-05	-4.2308E-05	-4.1816E-06	-2.3483E-05	-4.0410E-05
	VEL Y	-1.2459E-04	-1.1817E-04	-1.0301E-04	-1.0199E-04	-9.5781E-05	-8.1547E-05	-7.8206E-05	-7.1970E-05	-5.8444E-05
64	VEL X	6.6085E-07	5.8524E-07	6.9814E-07	7.0805E-07	8.0356E-07	6.0600E-07	5.9894E-07		
	VEL Y	4.6555E-06	4.7359E-06	4.7497E-06	4.4798E-06	4.5410E-06	4.4734E-06	4.9449E-06		

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LISTING D-6. Output Report File for Test Case Two. (Sheet 32 of 48)

SAMPLE PROBLEM. FLOW AROUND A HEATED CANNISTER

RESULTS FOR VELOCITY (M/YR) OF YEAR 5.000

ELEMENT	GSS PNT 1	GSS PNT 2	GSS PNT 3	GSS PNT 4	GSS PNT 5	GSS PNT 6	GSS PNT 7	GSS PNT 8	GSS PNT 9
65 VEL X	8.3943E-07	8.3140E-07	9.6396E-07	7.3048E-07	8.4059E-07	6.5211E-07	1.0252E-06		
VEL Y	4.7306E-06	4.8438E-06	4.6251E-06	4.7522E-06	4.5776E-06	4.9692E-06	4.7245E-06		
66 VEL X	8.2596E-07	9.3710E-07	8.5483E-07	6.8031E-07	6.3570E-07	7.6752E-07	1.0558E-06		
VEL Y	4.9581E-06	4.9266E-06	4.9363E-06	5.0143E-06	4.9778E-06	5.0651E-06	4.8750E-06		
67 VEL X	6.7747E-07	4.8567E-07	3.5628E-07	6.2919E-07	4.5789E-07	3.4216E-07	5.5820E-07	4.1140E-07	3.1222E-07
VEL Y	4.9823E-06	5.0714E-06	5.0881E-06	4.8893E-06	4.9948E-06	5.0619E-06	4.8491E-06	4.9604E-06	5.0499E-06
68 VEL X	2.8956E-07	2.0350E-07	1.3719E-07	2.7440E-07	1.9436E-07	1.3262E-07	2.5504E-07	1.8142E-07	1.2462E-07
VEL Y	4.8771E-06	4.9213E-06	4.9351E-06	4.8656E-06	4.9013E-06	4.9229E-06	4.8603E-06	4.8916E-06	4.916BE-06
69 VEL X	1.0533E-07	5.4757E-08	1.3146E-08	1.0077E-07	5.2745E-08	1.3201E-08	9.5204E-08	4.9789E-08	1.2390E-08
VEL Y	4.8128E-06	4.8264E-06	4.8237E-06	4.8032E-06	4.8143E-06	4.8180E-06	4.7983E-06	4.8080E-06	4.8149E-06
70 VEL X	-2.0096E-04	-2.5182E-04	-3.2907E-04	-1.0800E-04	-1.4328E-04	-1.7555E-04	-3.2953E-05	-5.7523E-05	-6.2370E-05
VEL Y	1.8957E-04	1.2618E-04	4.9690E-05	3.4779E-04	2.5893E-04	1.0479E-04	4.0258E-04	3.3556E-04	1.5937E-04
71 VEL X	-3.0152E-04	-3.7246E-04	-4.0071E-04	-2.5887E-04	-3.2957E-04	-3.8430E-04	-2.3471E-04	-2.9818E-04	-3.3375E-04
VEL Y	-4.1706E-04	-3.8334E-04	-2.7989E-04	-1.6186E-04	-1.8341E-04	-1.4861E-04	6.5868E-05	2.0559E-05	-1.8788E-05
72 VEL X	-2.4256E-05	-1.1277E-04	-2.2253E-04	-2.5308E-05	-1.0953E-04	-1.9657E-04	-2.7386E-05	-1.1108E-04	-1.8474E-04
VEL Y	-5.7813E-04	-5.4589E-04	-4.7998E-04	-1.5401E-04	-1.5578E-04	-1.7714E-04	1.5517E-04	1.5438E-04	9.9323E-05
73 VEL X	5.4685E-06	3.7612E-06	2.6125E-06	4.0966E-06	2.9349E-06	2.1653E-06	2.4844E-06	1.9774E-06	1.6416E-06
VEL Y	1.9772E-06	3.0872E-06	3.8872E-06	9.1304E-07	2.4502E-06	3.4896E-06	3.5998E-07	2.0985E-06	3.2441E-06
74 VEL X	5.0026E-05	5.0079E-05	5.0302E-05	2.5679E-05	2.5941E-05	2.6257E-05	6.1669E-06	6.3095E-06	6.4591E-06
VEL Y	-1.1097E-04	-1.2801E-04	-1.4420E-04	-1.2856E-04	-1.4828E-04	-1.6706E-04	-1.3560E-04	-1.5770E-04	-1.7890E-04
75 VEL X	2.2011E-06	1.6612E-06	1.2481E-06	1.8572E-06	1.4429E-06	1.1275E-06	1.4422E-06	1.1753E-06	9.7124E-07
VEL Y	4.0636E-06	4.5179E-06	4.8021E-06	3.7532E-06	4.3171E-06	4.6808E-06	3.5568E-06	4.1853E-06	4.5978E-06
76 VEL X	4.4318E-05	4.6225E-05	4.8257E-05	2.7192E-05	2.8397E-05	2.9653E-05	7.5483E-06	7.9132E-06	8.2864E-06
VEL Y	-5.7357E-05	-8.0403E-05	-1.0183E-04	-7.1500E-05	-9.5223E-05	-1.1755E-04	-7.8167E-05	-1.0187E-04	-1.2440E-04
77 VEL X	1.8694E-04	1.9941E-04	2.2614E-04	1.1315E-04	1.1223E-04	1.1615E-04	2.9309E-05	2.7882E-05	2.7491E-05
VEL Y	8.9256E-05	-1.7701E-04	-4.7951E-04	1.5431E-04	-1.5572E-04	-5.4564E-04	1.5513E-04	-1.5397E-04	-5.7799E-04
78 VEL X	1.0976E-06	1.2584E-06	9.9384E-07	1.0501E-06	8.5392E-07	1.2976E-06	1.1703E-06		
VEL Y	4.9783E-06	4.8465E-06	4.9679E-06	5.1090E-06	5.1231E-06	4.9763E-06	4.8003E-06		
79 VEL X	2.8186E-06	2.0527E-06	1.4503E-06	2.6040E-06	1.9139E-06	1.3772E-06	2.3595E-06	1.7602E-06	1.2991E-06
VEL Y	4.7913E-06	4.9159E-06	5.0209E-06	4.5000E-06	4.7536E-06	4.9210E-06	4.3160E-06	4.6570E-06	4.8612E-06
80 VEL X	1.3712E-06	1.1086E-06	8.9016E-07	1.3472E-06	1.0828E-06	8.6243E-07	1.3099E-06	1.0445E-06	8.2299E-07
VEL Y	5.3650E-06	5.3357E-06	5.3162E-06	5.2402E-06	5.2364E-06	5.2456E-06	5.0466E-06	5.0821E-06	5.1350E-06

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LISTING D-6. Output Report File for Test Case Two. (Sheet 33 of 48)

SAMPLE PROBLEM: FLOW AROUND A HEATED CANNISTER

RESULTS FOR VELOCITY (M/YR) OF YEAR 5.000

ELEMENT		GSS PNT 1	GSS PNT 2	GSS PNT 3	GSS PNT 4	GSS PNT 5	GSS PNT 6	GSS PNT 7	GSS PNT 8	GSS PNT 9
81	VEL X	7.6280E-07	5.4065E-07	3.9060E-07	7.2954E-07	5.1856E-07	3.7608E-07	6.9587E-07	4.9604E-07	3.6113E-07
	VEL Y	5.1130E-06	5.1328E-06	5.1423E-06	5.0594E-06	5.0976E-06	5.1231E-06	4.9752E-06	5.0418E-06	5.0924E-06
82	VEL X	3.2048E-07	2.2312E-07	1.4803E-07	3.0762E-07	2.1463E-07	1.4293E-07	2.9604E-07	2.0724E-07	1.3879E-07
	VEL Y	4.9294E-06	4.9450E-06	4.9557E-06	4.9167E-06	4.9361E-06	4.9476E-06	4.8962E-06	4.9215E-06	4.9347E-06
83	VEL X	1.1479E-07	5.9134E-08	1.3312E-08	1.1099E-07	5.7270E-08	1.3045E-08	1.0742E-07	5.5599E-08	1.2954E-08
	VEL Y	4.8326E-06	4.8364E-06	4.8375E-06	4.8256E-06	4.8319E-06	4.8330E-06	4.8144E-06	4.8246E-06	4.8258E-06
84	VEL X	-1.8110E-05	-8.3466E-05	-1.6000E-04	-1.1347E-05	-4.7162E-05	-8.3527E-05	-4.9314E-06	-1.4140E-05	-1.7952E-05
	VEL Y	2.9402E-04	2.9749E-04	2.1610E-04	4.6250E-04	4.6898E-04	3.7078E-04	5.3041E-04	5.5425E-04	4.5726E-04
85	VEL X	1.8196E-05	6.4518E-05	1.6183E-04	1.4355E-05	4.8074E-05	8.5117E-05	5.1345E-06	1.2207E-05	1.9635E-05
	VEL Y	4.5686E-04	3.7043E-04	2.1591E-04	5.5400E-04	4.6875E-04	2.9734E-04	5.3031E-04	4.6239E-04	2.9393E-04
86	VEL X	7.3727E-06	5.1749E-06	3.6150E-06	6.8558E-06	4.7697E-06	3.3124E-06	6.0939E-06	4.1856E-06	2.8768E-06
	VEL Y	6.2720E-06	5.3B12E-06	5.0355E-06	4.3186E-06	4.2446E-06	4.5087E-06	2.6947E-06	3.3567E-06	4.1208E-06
87	VEL X	8.1188E-05	8.5823E-05	9.0997E-05	7.3966E-05	7.7453E-05	8.1135E-05	6.1172E-05	6.2580E-05	6.3988E-05
	VEL Y	-5.3458E-05	-6.7262E-05	-7.9372E-05	-8.0979E-05	-9.6654E-05	-1.1057E-04	-1.0014E-04	-1.1907E-04	-1.3612E-04
88	VEL X	6.3078E-05	7.0431E-05	7.8333E-05	6.0305E-05	6.6420E-05	7.2651E-05	5.0991E-05	5.4343E-05	5.7630E-05
	VEL Y	-1.4586E-05	-3.1525E-05	-4.6201E-05	-3.5944E-05	-5.5391E-05	-7.2309E-05	-4.8496E-05	-7.1308E-05	-9.1376E-05
89	VEL X	3.3628E-04	3.8716E-04	4.0378E-04	3.0062E-04	3.3251E-04	3.7608E-04	2.3700E-04	2.6176E-04	3.0517E-04
	VEL Y	-1.8028E-05	-1.4789E-04	-2.7950E-04	2.0896E-05	-1.8297E-04	-3.8275E-04	6.5960E-05	-1.6167E-04	-4.1666E-04
90	VEL X	6.2858E-05	1.7681E-04	3.3139E-04	5.7928E-05	1.4442E-04	2.5388E-04	3.3250E-05	1.0904E-04	2.0286E-04
	VEL Y	1.5961E-04	1.0515E-04	5.0348E-05	3.3546E-04	2.5895E-04	1.2639E-04	4.0216E-04	3.4751E-04	1.8944E-04
91	VEL X	2.4138E-06	1.9570E-06	1.5980E-06	2.7185E-06	2.1081E-06	1.6268E-06	2.8514E-06	2.1071E-06	1.5182E-06
	VEL Y	6.2911E-06	5.8781E-06	5.6049E-06	5.7615E-06	5.5016E-06	5.4123E-06	4.9785E-06	4.9403E-06	5.1154E-06
92	VEL X	3.0331E-06	2.8910E-06	2.7907E-06	4.9102E-06	3.8698E-06	3.1329E-06	6.8035E-06	4.8783E-06	3.5084E-06
	VEL Y	8.4703E-06	7.3676E-06	6.7445E-06	8.2654E-06	6.9478E-06	6.1830E-06	7.9386E-06	6.3179E-06	5.3520E-06
93	VEL X	1.1305E-06	9.9048E-07	8.7435E-07	1.2557E-06	1.0624E-06	9.0099E-07	1.3434E-06	1.0985E-06	8.9471E-07
	VEL Y	5.9012E-06	5.7299E-06	5.6079E-06	5.7523E-06	5.6055E-06	5.5155E-06	5.5458E-06	5.4326E-06	5.3859E-06
94	VEL X	7.6894E-07	5.6430E-07	4.2606E-07	7.7500E-07	5.6062E-07	4.1579E-07	7.7136E-07	5.4908E-07	3.9891E-07
	VEL Y	5.3630E-06	5.2827E-06	5.2321E-06	5.2886E-06	5.2268E-06	5.1998E-06	5.1838E-06	5.1484E-06	5.1540E-06
95	VEL X	1.3129E-06	1.2628E-06	1.2238E-06	1.7274E-06	1.5227E-06	1.3625E-06	2.1320E-06	1.7754E-06	1.4955E-06
	VEL Y	6.6909E-06	6.3780E-06	6.1527E-06	6.5976E-06	6.2491E-06	5.9993E-06	6.4586E-06	6.0658E-06	5.7857E-06
96	VEL X	3.4707E-07	2.4195E-07	1.6086E-07	3.3720E-07	2.3495E-07	1.5609E-07	3.2686E-07	2.2755E-07	1.5095E-07
	VEL Y	5.0108E-06	4.9990E-06	4.9905E-06	4.9888E-06	4.9815E-06	4.9773E-06	4.9571E-06	4.9566E-06	4.9587E-06

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LISTING D-6. Output Report File for Test Case Two. (Sheet 34 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

ELEMENT

RESULTS FOR VELOCITY (M/VR) OF YEAR 5,000

GSS PNT 1 GSS PNT 2 GSS PNT 3 GSS PNT 4 GSS PNT 5 GSS PNT 6 GSS PNT 7 GSS PNT 8 GSS PNT 9

97	VEL X	1.2469E-07	6.3828E-08	1.3713E-08	4.8587E-06	4.8546E-06	4.8084E-08	1.3652E-08	4.8535E-06	4.8514E-06	4.8393E-06	6.0217E-08	1.3478E-08
98	VEL Y	1.7899E-06	2.3058E-06	2.7960E-06	2.4524E-06	2.7921E-06	3.4978E-06	4.4066E-06	4.3294E-06	5.8186E-06	5.8186E-06	6.8963E-06	1.2102E-05
99	VEL X	7.3275E-05	8.3379E-05	9.2051E-05	9.9194E-05	10.0510E-05	10.3625E-05	8.3625E-05	8.3625E-05	8.3625E-05	8.3625E-05	8.3625E-05	7.9999E-05
100	VEL Y	-8.7910E-06	-8.3379E-05	-9.2051E-05	-9.9194E-05	-10.0510E-05	-10.3625E-05	-8.3625E-05	-8.3625E-05	-8.3625E-05	-8.3625E-05	-8.3625E-05	-7.9999E-05
101	VEL X	8.9590E-06	3.0592E-05	3.3675E-05	2.1218E-05	2.7992E-05	2.7992E-05	7.0043E-05	7.3460E-05	7.3460E-05	7.3460E-05	7.3460E-05	6.6727E-05
102	VEL Y	9.8054E-07	1.1445E-06	1.2609E-06	1.4413E-06	1.2816E-06	7.0128E-06	1.6123E-06	1.7321E-06	2.1525E-06	2.2873E-06	2.3826E-06	7.6150E-06
103	VEL X	5.7826E-07	6.9415E-07	8.5412E-07	9.4646E-07	1.1070E-06	1.3021E-06	1.5806E-06	1.8177E-06	2.0730E-06	2.0730E-06	2.0730E-06	9.1577E-07
104	VEL Y	7.2518E-07	7.0393E-07	6.8636E-07	6.4226E-07	5.3444E-06	5.2226E-07	5.0035E-07	5.8800E-06	5.7572E-07	5.6565E-07	5.6562E-07	4.2594E-07
105	VEL X	6.4103E-07	5.1043E-07	5.9324E-06	5.8223E-07	8.7572E-07	8.0301E-06	6.0301E-06	5.8800E-06	5.7572E-06	5.6565E-06	5.6562E-07	9.1577E-07
106	VEL Y	6.1229E-07	6.7063E-07	6.3634E-06	7.1554E-07	8.1258E-07	8.4761E-07	8.7449E-07	8.2402E-06	6.4031E-06	6.4031E-06	6.4031E-06	6.10727E-06
107	VEL X	3.4565E-07	2.4439E-07	1.6629E-07	3.4891E-07	2.4554E-07	1.6581E-07	3.4889E-07	2.4554E-06	5.0195E-06	5.0195E-06	5.0195E-06	1.6679E-07
108	VEL Y	3.7399E-07	4.7814E-07	5.4995E-07	5.2056E-07	6.6055E-06	6.5669E-07	7.5085E-07	7.7176E-07	9.2088E-06	7.7342E-06	6.7342E-06	1.0245E-06
109	VEL X	6.7490E-06	6.6924E-06	6.4995E-06	6.6055E-07	6.5669E-06	6.9854E-06	6.5669E-06	6.8766E-06	7.2586E-06	7.2586E-06	7.2586E-06	6.8775E-06
110	VEL Y	3.0526E-07	8.6718E-07	1.4746E-06	1.3393E-06	1.2756E-07	1.3867E-08	1.2607E-07	1.2607E-06	6.4501E-08	1.2607E-06	1.2607E-06	1.2607E-06
111	VEL X	1.1694E-05	3.5690E-05	1.5592E-05	6.0157E-05	1.0782E-05	3.3739E-05	2.6203E-05	2.2478E-05	9.4976E-05	3.3456E-05	3.3456E-05	5.6103E-05
112	VEL Y	9.3925E-08	2.7939E-07	5.1142E-07	1.6342E-07	4.2406E-07	7.3703E-07	2.6649E-07	2.6649E-07	6.4258E-07	1.0748E-06	1.0748E-06	9.0854E-06

RESULTS FOR VELOCITY (M/YR) OF VEAR 5.000

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

LISTING D-6. Output Report File for Test Case Two. (Sheet 35 of 48)

ELEMENT QSS PNT 1 QSS PNT 2 QSS PNT 3 QSS PNT 4 QSS PNT 5 QSS PNT 6 QSS PNT 7 QSS PNT 8 QSS PNT 9

113	VEL X	5.4954E-07	5.4127E-07	4.4046E-07	6.3970E-07	5.2019E-07	7.4405E-06	7.1231E-06	7.4067E-06	7.7677E-07	3.0687E-07	6.8812E-06
114	VEL X	2.4256E-07	3.7068E-07	1.1926E-07	1.6292E-07	9.0180E-09	3.3019E-09	4.9151E-09	4.9151E-07	4.9523E-07	4.5214E-07	4.9422E-07
115	VEL X	1.1230E-07	2.1892E-07	7.0071E-06	6.7516E-06	7.0730E-06	7.1280E-07	1.1479E-07	3.5413E-07	3.3622E-07	6.7165E-06	6.4911E-06
116	VEL X	3.7213E-07	3.9406E-07	4.1213E-07	5.9477E-06	5.8828E-06	7.2058E-06	7.2283E-06	7.5485E-06	7.5029E-06	7.5029E-06	5.8331E-06
117	VEL X	4.1227E-07	3.6528E-07	3.3354E-07	4.4718E-07	3.4831E-07	4.0679E-07	4.9947E-07	4.2103E-07	5.8303E-07	4.7587E-07	4.0317E-07
118	VEL X	5.71213E-06	5.5732E-06	5.4581E-06	5.6763E-06	5.5323E-06	5.6763E-06	5.5323E-06	5.4120E-06	5.6420E-06	5.6420E-06	5.3648E-06
119	VEL Y	2.6168E-07	3.0988E-07	3.4718E-07	3.4831E-07	4.0679E-07	4.9947E-07	4.2103E-07	5.8303E-07	4.7587E-07	4.0317E-07	6.3147E-06
120	VEL X	5.2561E-06	5.1662E-06	5.0975E-06	5.1270E-07	3.1248E-07	5.1709E-07	1.5709E-07	3.3544E-07	1.6345E-07	2.3834E-07	1.6345E-07
121	VEL X	1.1325E-07	3.9179E-07	1.1026E-08	1.2069E-07	6.1465E-08	6.12668E-08	1.26299E-08	1.2668E-07	6.9033E-06	1.3182E-08	4.8975E-06
122	VEL X	1.4460E-07	1.9905E-07	2.8321E-07	7.0553E-08	9.7548E-08	1.4132E-07	3.5735E-08	5.1182E-08	7.8400E-08	6.6837E-06	6.4900E-06
123	VEL X	1.7185E-07	1.8984E-07	2.0463E-07	2.3193E-07	2.7139E-07	3.1140E-07	3.3489E-07	3.5424E-07	3.5424E-07	5.9281E-06	5.8310E-06
124	VEL X	2.0822E-07	1.9873E-07	1.9233E-07	2.8002E-07	2.5898E-07	2.4476E-07	3.5509E-07	3.2185E-07	2.9940E-07	5.2185E-07	5.4558E-06
125	VEL Y	1.1362E-07	1.3889E-07	1.5833E-07	1.5833E-07	1.5833E-07	1.9137E-07	2.1763E-07	2.1763E-07	2.1763E-07	2.9020E-07	2.9020E-07
126	VEL X	1.6965E-07	2.2573E-07	1.1850E-08	2.1616E-07	1.5891E-07	2.1475E-07	2.1475E-07	1.3903E-07	1.3903E-07	5.0933E-07	5.0933E-07
127	VEL X	6.2596E-08	8.5292E-08	1.0055E-07	8.6698E-08	1.1834E-07	1.2972E-07	1.2475E-07	1.2475E-07	1.2475E-07	1.8234E-07	6.1789E-06
128	VEL X	7.2787E-08	3.6128E-08	5.9409E-09	5.9905E-08	8.5271E-08	8.5271E-08	1.0571E-07	5.3229E-08	1.0013E-08	4.9351E-06	4.9351E-06

LISTING D-6. Output Report File for Test Case Two. (Sheet 36 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

RESULTS FOR VELOCITY (M/YR) OF VEAR 5.000

ELEMENT	GSS PNT 1	GSS PNT 2	GSS PNT 3	GSS PNT 4	GSS PNT 5	GSS PNT 6	GSS PNT 7	GSS PNT 8	GSS PNT 9		
129	VEL X	6.1853E-08	8.6799E-08	1.1832E-07	3.0498E-08	5.8040E-08	6.2313E-06	6.0884E-06	1.4656E-08	2.0686E-08	2.9219E-08
130	VEL Y	1.5672E-08	1.7591E-08	1.9164E-08	2.4499E-08	5.8135E-06	5.8616E-06	5.2499E-06	8.0832E-08	8.7673E-08	1.4804E-07
131	VEL X	2.0645E-08	1.9958E-08	1.7490E-06	5.6362E-06	9.1568E-08	9.4749E-06	8.6470E-08	5.4958E-06	5.7504E-06	1.5706E-07
132	VEL Y	1.0311E-08	1.2856E-08	1.4804E-08	4.7703E-08	5.8754E-08	6.7233E-08	6.4804E-08	5.9937E-06	5.9714E-06	1.0731E-07
133	VEL X	1.7961E-08	1.3435E-08	9.9446E-09	5.2543E-06	5.9446E-08	7.8306E-08	5.8406E-08	4.3057E-08	5.1347E-06	1.3652E-07
134	VEL Y	5.5107E-09	7.7891E-09	9.3011E-09	2.5956E-08	3.5814E-08	4.2383E-08	4.8947E-08	6.0508E-06	6.0413E-06	7.7152E-08
135	VEL X	7.8295E-09	3.9637E-09	7.8046E-10	3.4193E-09	1.7106E-08	3.0360E-09	5.9735E-08	2.9507E-08	4.6153E-09	4.9607E-06
136	VEL Y	5.5247E-09	2.5967E-08	4.7104E-08	2.8297E-09	1.2905E-08	2.3470E-08	1.3725E-09	6.2333E-09	1.1342E-08	6.0657E-06

LISTING D-6. Output Report File for Test Case Two. (Sheet 37 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

RESULTS ON YEAR 10.00

NODE	T(C)	H(M)	NODE	T(C)	H(M)	NODE	T(C)	H(M)
1	50.00	*	1.200	*		51	53.67	1.155
2	50.00	*	1.200	*		52	53.95	1.155
3	50.00	*	1.200	*		53	51.81	1.168
4	50.00	*	1.200	*		54	52.37	1.157
5	50.00	*	1.200	*		55	53.08	1.156
6	50.00	*	1.200	*		56	50.89	1.169
7	50.00	*	1.200	*		57	51.16	1.159
8	50.00	*	1.200	*		58	51.70	1.158
9	50.00	*	1.200	*		59	50.53	1.169
10	50.00	*	1.200	*		60	50.69	1.159
11	50.00	*	1.200	*		61	50.82	1.159
12	50.00	*	1.200	*		62	55.97	1.143
13	50.00	*	1.200	*		63	57.58	1.132
14	50.00	*	1.200	*		64	57.65	1.132
15	50.00	*	1.200	*		65	57.70	1.132
16	51.07		1.188			66	56.04	1.143
17	52.17		1.176			67	55.78	1.143
18	52.18		1.176			68	57.28	1.132
19	52.19		1.176			69	57.47	1.132
20	51.08		1.188			70	55.35	1.144
21	51.05		1.188			71	56.62	1.133
22	52.13		1.176			72	57.00	1.133
23	52.16		1.176			73	54.63	1.145
24	51.00		1.188			74	55.59	1.135
25	52.02		1.177			75	56.15	1.134
26	52.08		1.176			76	52.91	1.147
27	50.90		1.188			77	53.39	1.137
28	51.81		1.177			78	54.53	1.136
29	51.92		1.177			79	51.40	1.149
30	50.61		1.189			80	51.61	1.139
31	51.21		1.176			81	52.38	1.138
32	51.55		1.177			82	50.83	1.149
33	50.31		1.190			83	50.95	1.139
34	50.61		1.179			84	51.13	1.139
35	50.88		1.179			85	58.92	1.125
36	50.18		1.190			86	60.54	1.117
37	50.36		1.179			87	59.02	1.124
38	50.43		1.179			88	59.01	1.124
39	53.33		1.165			89	60.54	1.117
40	54.58		1.154			90	60.52	1.117
41	54.60		1.154			91	58.57	1.125
42	54.62		1.154			92	59.86	1.118
43	53.36		1.165			93	60.27	1.117
44	53.25		1.165			94	60.57	1.117
45	54.46		1.154			95	60.60	1.117
46	54.53		1.154			96	59.11	1.124
47	53.07		1.165			97	57.64	1.126
48	54.17		1.154			98	58.56	1.120
49	54.34		1.154			99	59.28	1.119
50	52.73		1.166			100	56.31	1.128

LISTING D-6. Output Report File for Test Case Two. (Sheet 38 of 48)

SAMPLE PROBLEM. FLOW AROUND A HEATED CANNISTER

RESULTS ON YEAR 10.00

NODE	T(C)	H(M)	NODE	T(C)	H(M)	NODE	T(C)	H(M)
151	62.25	1.104	201	68.51	1.096	251	67.61	1.102
152	57.90	1.109	202	69.08	1.097	252	68.07	1.102
153	58.03	1.106	203	69.03	1.096	253	68.18	1.101
154	59.30	1.106	204	69.09	1.098	254	62.24	1.098
155	54.30	1.110	205	69.03	1.097	255	68.56	1.102
156	54.34	1.107	206	68.56	1.098	256	69.09	1.102
157	56.06	1.107	207	67.36	1.100	257	69.21	1.101
158	51.97	1.111	208	67.26	1.099	258	69.76	1.102
159	51.99	1.108	209	63.89	1.101	259	70.31	1.103
160	52.97	1.108	210	63.95	1.100	260	70.71	1.101
161	51.16	1.111	211	65.67	1.100	261	59.30	1.095
162	51.17	1.108	212	68.30	1.100	262	60.72	1.095
163	51.38	1.108	213	68.18	1.099	263	60.71	1.096
164	68.28	1.095	214	67.82	1.100	264	62.25	1.096
165	67.80	1.095	215	60.78	1.102	265	63.87	1.098
166	67.59	1.095	216	60.81	1.100	266	63.82	1.098
167	68.05	1.095	217	62.32	1.100	267	57.90	1.091
168	68.16	1.095	218	69.30	1.100	268	57.69	1.088
169	67.50	1.096	219	69.21	1.099	269	58.81	1.089
170	67.98	1.096	220	68.79	1.100	270	59.99	1.090
171	67.98	1.096	221	59.42	1.100	271	60.43	1.093
172	67.17	1.098	222	59.34	1.098	272	54.30	1.090
173	67.11	1.097	223	60.73	1.097	273	54.23	1.086
174	63.82	1.102	224	60.78	1.099	274	55.87	1.087
175	63.84	1.101	225	58.11	1.096	275	51.97	1.089
176	65.52	1.100	226	58.03	1.094	276	51.95	1.086
177	68.07	1.098	227	59.23	1.096	277	52.91	1.086
178	67.99	1.097	228	54.37	1.096	278	51.16	1.089
179	67.61	1.098	229	54.34	1.093	279	51.15	1.085
180	60.71	1.104	230	56.06	1.093	280	51.35	1.085
181	60.73	1.103	231	52.00	1.095	281	71.41	1.100
182	62.24	1.102	232	51.99	1.092	282	71.29	1.099
183	59.23	1.105	233	52.97	1.093	283	71.29	1.100
184	58.17	1.100	234	51.18	1.095	284	70.71	1.103
185	59.34	1.102	235	51.17	1.092	285	70.88	1.102
186	58.11	1.104	236	51.38	1.092	286	71.29	1.101
187	54.37	1.105	237	70.88	1.098	287	65.54	1.101
188	54.39	1.100	238	70.22	1.097	288	67.05	1.104
189	56.14	1.100	239	69.75	1.097	289	67.11	1.103
190	52.00	1.105	240	70.31	1.098	290	67.50	1.104
191	52.01	1.100	241	70.71	1.098	291	67.98	1.104
192	53.00	1.100	242	69.76	1.098	292	67.99	1.103
193	51.18	1.105	243	70.89	1.100	293	68.51	1.104
194	51.18	1.100	244	70.71	1.099	294	69.08	1.104
195	51.39	1.100	245	70.23	1.100	295	69.03	1.103
196	69.29	1.095	246	63.89	1.100	296	69.03	1.104
197	68.77	1.095	247	63.84	1.099	297	69.08	1.105
198	68.55	1.095	248	65.52	1.100	298	69.75	1.104
199	69.08	1.096	249	67.17	1.102	299	69.20	1.105
200	69.20	1.095	250	67.26	1.101	300	69.29	1.105

2 1 2 3 1 4 5

LISTING D-6. Output Report File for Test Case Two. (Sheet 39 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

RESULTS ON YEAR 10.00

NODE	T(C)	H(M)	NODE	T(C)	H(M)	NODE	T(C)	H(M)
301	70.22	1.104	350	54.53	1.064	399	54.60	1.046
302	61.17	1.091	351	57.00	1.067	400	52.73	1.034
303	62.25	1.093	352	57.28	1.068	401	51.81	1.023
304	63.21	1.096	353	58.57	1.076	402	51.92	1.023
305	63.18	1.095	354	51.74	1.069	403	52.02	1.023
306	63.82	1.096	355	51.61	1.061	404	53.07	1.035
307	65.52	1.101	356	52.38	1.062	405	51.81	1.033
308	57.35	1.084	357	57.47	1.068	406	51.21	1.022
309	56.89	1.079	358	57.58	1.068	407	51.55	1.023
310	57.75	1.080	359	59.01	1.076	408	52.08	1.024
311	58.56	1.081	360	51.03	1.068	409	52.13	1.024
312	59.36	1.086	361	50.95	1.061	410	53.25	1.035
313	54.11	1.082	362	51.13	1.061	411	50.89	1.031
314	53.94	1.076	363	67.34	1.106	412	50.61	1.021
315	55.40	1.077	364	67.23	1.106	413	50.88	1.021
316	59.28	1.082	365	63.81	1.095	414	52.16	1.024
317	59.86	1.082	366	63.87	1.096	415	52.17	1.024
318	61.11	1.088	367	65.62	1.101	416	53.33	1.035
319	51.90	1.081	368	67.80	1.106	417	50.53	1.031
320	51.84	1.075	369	60.57	1.083	418	50.34	1.021
321	52.73	1.076	370	60.60	1.083	419	50.43	1.021
322	51.12	1.080	371	62.19	1.090	420	52.19	1.024
323	51.08	1.075	372	58.92	1.076	421	53.36	1.035
324	51.28	1.075	373	57.70	1.068	422	52.18	1.024
325	67.15	1.106	374	59.02	1.076	423	50.90	1.012
326	67.09	1.105	375	57.65	1.068	424	50.00	*
327	63.76	1.096	376	59.11	1.076	425	50.00	*
328	63.77	1.095	377	54.63	1.055	426	50.00	*
329	65.48	1.101	378	53.67	1.045	427	51.00	1.012
330	68.05	1.105	379	53.95	1.045	428	50.61	1.011
331	67.98	1.105	380	54.17	1.046	429	50.00	*
332	67.59	1.105	381	55.35	1.056	430	50.00	*
333	68.55	1.105	382	52.91	1.053	431	50.00	*
334	68.16	1.105	383	52.37	1.043	432	50.00	*
335	68.28	1.105	384	53.08	1.044	433	51.05	1.012
336	68.77	1.105	385	54.34	1.046	434	50.31	1.011
337	60.27	1.083	386	54.46	1.046	435	50.00	*
338	60.54	1.084	387	55.78	1.057	436	50.00	*
339	62.15	1.090	388	51.40	1.051	437	50.00	*
340	60.52	1.083	389	51.16	1.041	438	50.00	*
341	60.54	1.083	390	51.70	1.042	439	51.07	1.012
342	62.11	1.090	391	54.53	1.046	440	50.18	1.010
343	56.31	1.072	392	54.58	1.046	441	50.00	*
344	55.59	1.065	393	55.97	1.057	442	50.00	*
345	56.15	1.066	394	50.83	1.051	443	50.00	*
346	56.62	1.067	395	50.69	1.041	444	51.08	1.012
347	57.64	1.074	396	50.82	1.041	445	50.00	*
348	53.71	1.070	397	54.62	1.047			
349	53.39	1.063	398	56.04	1.057			

ITERATION NUMBER 1. MAX CHANGE (TEMP) = 1.1606E-05, MAX REL CORRECTION = 2.3840E-03
 ITERATION NUMBER 1. MAX CHANGE (HEAD) = 2.3516E-03, MAX REL CORRECTION = 7.9769E-03

RHO-BH-GR-143 P

LISTING D-6. Output Report File for Test Case Two. (Sheet 40 of 48)

RESULTS FOR VELOCITY (M/YR) OF YEAR 10.00

SAMPLE PROBLEM: FLOW AROUND A HEATED CANNISTER

QSS PNT 1 QSS PNT 2 QSS PNT 3 QSS PNT 4 QSS PNT 5 QSS PNT 6 QSS PNT 7 QSS PNT 8 QSS PNT 9

RESULTS FOR VELCITY (M/YR) OF YEAR 10, 00

SAMPLE PROBLEM: FOLD AROUND A HEEDED CANNISTER

LISTING D-6. Output Report File for Test Case Two. (Sheet 40 of 48)

For more information about the study, please contact Dr. Michael J. Koenig at (314) 747-2146 or via email at koenig@dfci.harvard.edu.

LISTING D-6. Output Report File for Test Case Two. (Sheet 41 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

RESULTS FOR VELOCITY (M/YR) OF YEAR 10.00

ELEMENT OSS PNT 1 OSS PNT 2 OSS PNT 3 OSS PNT 4 OSS PNT 5 OSS PNT 6 OSS PNT 7 OSS PNT 8 OSS PNT 9

17	VEL X	-3.7788E-07 -2.8417E-06 5.6327E-06 5.6327E-07 -3.5997E-07 -2.5544E-07 -1.9920E-07 -3.1887E-07 -2.2413E-07 -1.6975E-07	VEL Y	5.6668E-06 5.6327E-06 5.6037E-06 5.7446E-06 5.6871E-06 5.6359E-06 5.8133E-06 5.7331E-06 5.6604E-06
18	VEL X	-3.5562E-07 -2.9646E-07 -2.5544E-07 -3.5997E-07 -2.5544E-07 -2.5544E-07 -1.9920E-07 -3.1887E-07 -2.2413E-07 -1.6975E-07	VEL Y	5.4184E-06 5.4361E-06 5.4551E-06 5.4947E-06 5.4947E-06 5.4693E-07 5.4935E-06 5.5719E-06 5.5507E-06 5.5336E-06
19	VEL X	-2.0052E-07 -1.9597E-06 5.1543E-06 5.1787E-06 5.1887E-06 5.2136E-06 5.2072E-07 -2.2971E-07 -2.4979E-07	VEL Y	5.1287E-06 5.1543E-06 5.1887E-06 5.2136E-06 5.2072E-07 -2.3497E-07 -2.1298E-07 -3.3072E-07 -2.2971E-07 -2.4979E-07
20	VEL X	-6.8879E-08 -7.2393E-08 -7.2446E-08 -1.0876E-08 -1.1044E-07 -1.0820E-07 -1.1.6046E-07 -1.5976E-07 -1.5456E-07	VEL Y	4.9268E-06 4.9377E-06 4.9478E-06 4.9419E-06 4.9598E-06 4.9766E-06 4.9701E-06 4.9937E-06 5.0115E-06
21	VEL X	-3.6227E-09 -3.9243E-09 -3.4833E-09 -2.6347E-08 -2.7350E-08 -2.7559E-08 -2.7559E-08 -5.3944E-08 -5.5799E-08 -5.6752E-08	VEL Y	4.8222E-06 4.8272E-06 4.8317E-06 4.8253E-06 4.8324E-06 4.8390E-06 4.8341E-06 4.8424E-06 4.8500E-06
22	VEL X	-1.6503E-07 -2.5197E-07 -1.4705E-07 -1.1772E-07 -7.8330E-08 -2.2162E-07 -2.4528E-07	VEL Y	6.1831E-06 6.2275E-06 6.2760E-06 6.0546E-06 6.1147E-06 6.0281E-06 6.4235E-06
23	VEL X	-3.7981E-07 -3.7184E-07 -4.5271E-07 -3.0208E-07 -3.6508E-07 -2.0426E-07 -2.4889E-07	VEL Y	6.3018E-06 6.5384E-06 6.3236E-06 6.5318E-06 6.1362E-06 6.4927E-06
24	VEL X	-6.8575E-07 -4.9528E-07 -3.8950E-07 -6.2349E-07 -4.3701E-07 -4.3701E-07 -5.3390E-07 -3.5276E-07 -3.5276E-07	VEL Y	6.1128E-06 6.0294E-06 5.9507E-06 6.2658E-06 6.1222E-06 6.0119E-06 6.3921E-06 6.2111E-06 6.0524E-06
25	VEL X	-7.8272E-08 -1.5263E-07 9.2103E-09 -1.1423E-07 4.7521E-09 -2.7357E-07 -3.2488E-08	VEL Y	6.4692E-06 6.6311E-06 6.4037E-06 6.3867E-06 6.2295E-06 6.5932E-06 6.6241E-06
26	VEL X	-6.5976E-07 -5.3651E-07 -4.4527E-07 -6.7852E-07 -5.3343E-07 -4.2404E-07 -7.0262E-07 -5.2951E-07 -3.9676E-07	VEL Y	5.6303E-06 5.6694E-06 5.6917E-06 5.7873E-06 5.7951E-06 5.7710E-06 5.9602E-06 5.8515E-06
27	VEL X	-4.3314E-07 -4.1618E-07 -3.9381E-07 -5.1007E-07 -4.6600E-07 -4.1597E-07 -6.0287E-07 -5.2617E-07 -4.4276E-07	VEL Y	5.3033E-06 5.3668E-06 5.4106E-06 5.3719E-06 5.4323E-06 5.4730E-06 5.4670E-06 5.5214E-06 5.5565E-06
28	VEL X	-1.7082E-07 -1.8974E-07 -2.0234E-07 -2.5135E-07 -2.6092E-07 -2.6299E-07 -3.7557E-07 -3.6631E-07 -3.52274E-07	VEL Y	5.0794E-06 5.1067E-06 5.1247E-06 5.0835E-06 5.1295E-06 5.1615E-06 5.1270E-06 5.1862E-06 5.2274E-07
29	VEL X	-5.1953E-08 -5.9382E-08 -8.7498E-08 -9.7241E-08 -1.0611E-07 -1.3358E-07 -1.4632E-07 -1.5806E-07	VEL Y	4.9156E-06 4.9244E-06 4.9298E-06 4.9101E-06 4.9242E-06 4.9331E-06 4.9277E-06 4.9396E-06
30	VEL X	-2.7330E-09 -3.0801E-09 -3.3497E-09 -2.0494E-08 -2.2711E-08 -2.2587E-08 -4.1074E-08 -4.6548E-08	VEL Y	4.8145E-06 4.8183E-06 4.8205E-06 4.8140E-06 4.8187E-06 4.8105E-06 4.8206E-06
31	VEL X	-8.0458E-07 -5.3675E-07 -3.5821E-07 -4.9041E-07 -3.1212E-07 -1.9554E-07 -2.1505E-07 -1.2406E-07 -6.5292E-08	VEL Y	7.7550E-06 7.2008E-06 6.7548E-06 7.6191E-06 7.2689E-06 6.7955E-06 7.9475E-06 7.3224E-06 6.8261E-06
32	VEL X	-1.5471E-06 -9.3592E-07 -5.9425E-07 -1.3809E-06 -8.0554E-07 -1.2176E-06 -6.9482E-07 -4.0434E-07	VEL Y	7.2406E-06 6.9187E-06 6.6474E-06 7.4289E-06 7.0208E-06 6.6818E-06 7.6432E-06 7.1381E-06 6.7253E-06

LISTING D-6. Output Report File for Test Case Two. (Sheet 42 of 48)

RESULTS FOR VELOCITY (M/VR) OF YEAR 10.00

SAMPLE PROBLEM, FLUID AROUND A HEATED CANNISTER

ELEMENT QSS PNT 1 QSS PNT 2 QSS PNT 3 QSS PNT 4 QSS PNT 5 QSS PNT 6 QSS PNT 7 QSS PNT 8 QSS PNT 9

33	VEL X	-1.6500E-06	-1.1803E-06	-8.4833E-07	-1.1.400E-06	6.5556E-06	1.1243E-06	-7.8283E-07	-1.1.5925E-06	-1.1.0444E-06	-6.8856E-07
34	VEL X	-8.2999E-07	-7.9223E-07	-4.4491E-07	-5.3264E-07	-5.5055E-07	-5.3956E-07	-5.2620E-06	5.1010E-06	5.3163E-06	5.1281E-06
35	VEL X	-3.5906E-07	-4.2628E-07	-4.4491E-07	-5.3264E-07	-5.5055E-07	-5.3956E-07	-5.2620E-06	5.1010E-06	5.3163E-06	5.1281E-06
36	VEL Y	-1.1336E-07	-1.3834E-07	-1.6002E-07	-1.9013E-07	-2.1836E-07	-2.4308E-07	-3.0326E-07	-3.3681E-07	-3.6605E-07	-5.4038E-06
37	VEL X	-3.2332E-08	-3.9456E-08	-4.7403E-08	-5.7247E-08	-6.8703E-08	-8.1099E-08	-8.6020E-08	-9.1779E-08	-9.8040E-08	-1.2478E-07
38	VEL X	-1.7138E-09	-1.9393E-09	-2.4539E-09	-1.2877E-08	-1.5445E-08	-1.8401E-08	-1.1099E-08	-8.8.6020E-08	-8.1779E-08	-3.7764E-08
39	VEL X	-2.9658E-06	-2.0142E-06	-1.1320E-06	-1.3108E-06	-1.1.0059E-06	-6.7317E-07	-2.3.9364E-07	-7.7.944E-08	-2.4329E-07	-1.0543E-05
40	VEL X	-5.5242E-06	-3.4498E-06	-2.1261E-06	-4.7384E-06	-2.7641E-06	-1.7.689E-06	-1.1.0053E-06	-3.5626E-06	-1.9320E-06	-1.3.7277E-06
41	VEL X	-2.2586E-06	-2.0797E-06	-1.9279E-06	-3.5288E-06	-2.8053E-06	-2.0803E-06	-5.2746E-06	-3.8039E-06	-2.2962E-06	-4.6008E-06
42	VEL X	-6.6275E-07	-8.2021E-07	-8.6372E-07	-1.1.2222E-06	-1.2115E-06	-1.1.1752E-06	-1.1.7077E-06	-1.1.5714E-06	-1.1.5125E-06	-4.8016E-06
43	VEL X	-2.4849E-07	-3.0345E-07	-3.5641E-07	-3.7647E-07	-4.4.363E-07	-5.0894E-07	-5.2993E-07	-6.3190E-07	-6.9222E-07	-4.9839E-06
44	VEL X	-6.3030E-08	-8.0566E-08	-1.0032E-07	-1.1.036E-07	-1.1.036E-07	-1.1.7226E-07	-1.1.2794E-07	-2.2794E-07	-2.7879E-07	-5.0359E-06
45	VEL X	-1.7093E-08	-2.1934E-08	-2.8227E-08	-3.1117E-08	-4.4.0060E-08	-5.0765E-08	-4.9380E-08	-6.3602E-08	-7.9872E-08	-4.9093E-06
46	VEL X	-9.1469E-10	-1.0336E-09	-1.4786E-09	-1.6.8417E-09	-1.1.1186E-08	-1.1.4083E-08	-1.1.8330E-08	-1.4.7928E-08	-1.2.2983E-08	-4.8097E-06
47	VEL X	-5.5119E-05	-5.7909E-05	-5.5220E-05	-3.1117E-05	-3.3138E-05	-3.4970E-05	-3.05075E-06	-1.1.0506E-05	-1.1.1294E-05	-1.1.5692E-05
48	VEL X	-8.1054E-05	-8.5368E-05	-8.9974E-05	-7.7.3121E-05	-8.1893E-05	-8.6602E-05	-8.30855E-05	-1.1.05200E-05	-1.1.1921E-05	-1.1.7884E-05

ELLEMENT GSS PNT 1 GSS PNT 2 GSS PNT 3 GSS PNT 4 GSS PNT 5 GSS PNT 6 GSS PNT 7 GSS PNT 8 GSS PNT 9

RESULTS FOR VELOCITY (M/YR) OF YEAR

SAMPLE PROBLEM. FLOW AROUND A HEATED CANNISTER

LISTING D-6. Output Report File for Test Case Two. (Sheet 43 of 48)

RESULTS FOR VELOCITY (M/YR) DE YEAR

SAMPLE PROBLEM. FLOW AROUND A HEATED CANNISTER

LISTING D-6. Output Report File for Test Case Two. (Sheet 43 of 48)

LISTING D-6. Output Report File for Test Case Two. (Sheet 44 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

60

RESULTS FOR VELOCITY (M/VR) OF YEAR

10.00

ELEMENT OSS PNT 1 OSS PNT 2 OSS PNT 3 OSS PNT 4 OSS PNT 5 OSS PNT 6 OSS PNT 7 OSS PNT 8 OSS PNT 9

65 VEL X 9.1318E-08 1.2518E-07 1.2973E-06 4.7910E-06 1.8365E-08 3.0397E-08 2.8989E-08 2.1135E-07

VEL Y 4.6943E-08 1.2518E-07 1.2973E-06 4.5539E-06 4.7520E-06 4.5606E-06 4.9578E-06 4.6005E-06

VEL X 4.8646E-06 4.9233E-06 5.0339E-06 4.8326E-06 4.9571E-06 5.0355E-06 4.8193E-06 4.9415E-06

VEL Y 4.5565E-08 2.9749E-08 1.7620E-08 2.9069E-08 1.9756E-08 1.2572E-08 8.6394E-09 4.1851E-09 4.2761E-09

VEL X 4.8339E-06 4.8895E-06 4.9113E-06 4.8442E-06 4.8858E-06 4.9113E-06 4.8494E-06 4.8842E-06 4.9114E-06

VEL Y 1.3574E-08 6.8434E-09 1.3347E-09 8.6651E-09 4.8093E-09 1.3273E-09 4.6409E-09 2.8290E-09 5.1036E-10

VEL X 4.7927E-06 4.8099E-06 4.8093E-06 4.7934E-06 4.8064E-06 4.8108E-06 4.7937E-06 4.8045E-06 4.8117E-06

VEL Y 2.1210E-04 1.4765E-04 6.9930E-05 3.7057E-04 2.8053E-04 1.2513E-04 1.2513E-04 3.5728E-04 6.2265E-05

VEL X -2.0083E-04 -2.5142E-04 -3.2837E-04 -1.0794E-04 -1.4305E-04 -1.7520E-04 -3.2918E-05 -5.7404E-05 -6.2265E-05

VEL Y 2.1210E-04 1.4765E-04 6.9930E-05 3.7057E-04 2.8053E-04 1.2513E-04 1.2513E-04 3.5728E-04 6.2265E-05

VEL X 3.4119E-06 2.0870E-06 1.1975E-06 2.0391E-06 1.2327E-06 7.0872E-07 4.7496E-07 2.8713E-07 1.6483E-07

VEL Y 3.4119E-06 2.0870E-06 1.1975E-06 2.0391E-06 1.2327E-06 7.0872E-07 4.7496E-07 2.8713E-07 1.6483E-07

VEL X -2.5612E-05 -1.1372E-04 -4.5230E-04 -2.6411E-04 -1.1025E-05 -1.3154E-04 -1.3333E-04 -1.5477E-04 -1.1155E-04

VEL Y -2.5612E-05 -1.1372E-04 -4.5230E-04 -2.6411E-04 -1.1025E-05 -1.3154E-04 -1.3333E-04 -1.5477E-04 -1.1155E-04

VEL X 4.7868E-05 4.7836E-05 4.7973E-05 2.3591E-05 2.3756E-05 2.3993E-05 4.2884E-06 4.4313E-06 4.4810E-06

VEL Y -1.0979E-04 -1.2666E-04 -1.4307E-05 2.3591E-05 2.3756E-05 2.3993E-05 4.2884E-06 4.4313E-06 4.4810E-06

VEL X 4.7868E-05 4.7836E-05 4.7973E-05 2.3591E-05 2.3756E-05 2.3993E-05 4.2884E-06 4.4313E-06 4.4810E-06

VEL Y -1.0979E-04 -1.2666E-04 -1.4307E-05 2.3591E-05 2.3756E-05 2.3993E-05 4.2884E-06 4.4313E-06 4.4810E-06

VEL X 3.4119E-06 2.0870E-06 1.1975E-06 2.0391E-06 1.2327E-06 7.0872E-07 4.7496E-07 2.8713E-07 1.6483E-07

VEL Y 3.4119E-06 2.0870E-06 1.1975E-06 2.0391E-06 1.2327E-06 7.0872E-07 4.7496E-07 2.8713E-07 1.6483E-07

VEL X -2.5612E-05 -1.1372E-04 -4.5230E-04 -2.6411E-04 -1.1025E-05 -1.3154E-04 -1.3333E-04 -1.5477E-04 -1.1155E-04

VEL Y -2.5612E-05 -1.1372E-04 -4.5230E-04 -2.6411E-04 -1.1025E-05 -1.3154E-04 -1.3333E-04 -1.5477E-04 -1.1155E-04

VEL X 4.2369E-05 4.4208E-05 4.6168E-05 2.5410E-05 2.6518E-05 2.7674E-05 6.0186E-06 6.2552E-06 6.4952E-06

VEL Y -5.5992E-05 -4.4208E-05 -1.0060E-04 -6.9708E-05 -9.3507E-05 -1.1.1590E-04 -7.6093E-05 -9.8847E-05 -1.2244E-04

VEL X 1.8500E-04 1.9714E-04 2.2343E-04 1.1157E-04 1.1042E-04 1.1406E-04 2.6181E-05 2.6516E-05 2.5879E-05

VEL Y 1.8500E-04 1.9714E-04 2.2343E-04 1.1157E-04 1.1042E-04 1.1406E-04 2.6181E-05 2.6516E-05 2.5879E-05

VEL X 3.7218E-07 4.4793E-07 4.7416E-06 4.0528E-06 4.4389E-06 4.9736E-07 1.1065E-06 7.0947E-07 4.0584E-07

VEL Y 1.6213E-06 1.0382E-06 5.8029E-06 1.3813E-06 1.3813E-06 4.9736E-07 1.1065E-06 7.0947E-07 4.0584E-07

VEL X 4.2504E-06 4.5328E-06 4.5328E-06 4.0528E-06 4.4389E-06 4.9736E-07 1.1065E-06 7.0947E-07 4.0584E-07

VEL Y 4.2504E-06 4.5328E-06 4.5328E-06 4.0528E-06 4.4389E-06 4.9736E-07 1.1065E-06 7.0947E-07 4.0584E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL Y 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07

VEL X 4.9613E-07 5.1329E-07 3.6113E-07 4.1577E-07 4.4801E-07 3.0825E-07 5.3373E-07 3.8085E-07 2.5336E-07</div

LISTING D-6. Output Report File for Test Case Two. (Sheet 45 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

RESULTS FOR VELOCITY (M/YR) OF YEAR 10.00

ELEMENT		GSS PNT 1	GSS PNT 2	GSS PNT 3	GSS PNT 4	GSS PNT 5	GSS PNT 6	GSS PNT 7	GSS PNT 8	GSS PNT 9
81	VEL X	2.8363E-07	1.7671E-07	1.0452E-07	2.32B9E-07	1.4447E-07	8.4819E-08	1.8563E-07	1.1493E-07	6.7319E-08
	VEL Y	4.9258E-06	5.0024E-06	5.0523E-06	4.8977E-06	4.9894E-06	5.0473E-06	4.8553E-06	4.9661E-06	5.0373E-06
82	VEL X	8.3708E-08	5.3815E-08	3.0772E-08	6.7478E-08	4.3141E-08	2.4401E-08	5.3283E-08	3.4218E-08	1.9574E-08
	VEL Y	4.8578E-06	4.8915E-06	4.9157E-06	4.8554E-06	4.8913E-06	4.9139E-06	4.8501E-06	4.8897E-06	4.9103E-06
83	VEL X	2.4849E-08	1.2157E-08	1.7128E-09	2.0212E-08	9.8152E-09	1.2714E-09	1.5977E-08	7.8280E-09	1.1534E-09
	VEL Y	4.7988E-06	4.8085E-06	4.8132E-06	4.7969E-06	4.8086E-06	4.8123E-06	4.7935E-06	4.8082E-06	4.8105E-06
84	VEL X	-1.8826E-05	-8.3871E-05	-1.6007E-04	-1.1743E-05	-4.7394E-05	-8.3586E-05	-5.0115E-06	-1.4203E-05	-1.7987E-05
	VEL Y	3.1739E-04	3.2084E-04	2.3938E-04	4.8612E-04	4.9258E-04	3.9434E-04	5.5414E-04	5.7796E-04	4.8094E-04
85	VEL X	1.7985E-05	8.3633E-05	1.6018E-04	1.4156E-05	4.7376E-05	8.3884E-05	5.0068E-06	1.1696E-05	1.8734E-05
	VEL Y	4.7791E-04	3.9131E-04	2.3642E-04	5.7622E-04	4.9082E-04	3.1915E-04	5.5367E-04	4.8558E-04	3.1688E-04
86	VEL X	5.6331E-06	3.6588E-06	2.2584E-06	4.9688E-06	3.1736E-06	1.9221E-06	4.0771E-06	2.5322E-06	1.4765E-06
	VEL Y	4.8996E-06	4.4232E-06	4.3515E-06	3.2457E-06	3.5079E-06	3.9611E-06	1.9373E-06	2.8341E-06	3.7041E-06
87	VEL X	7.9217E-05	8.3768E-05	8.8852E-05	7.1844E-05	7.5252E-05	7.8849E-05	5.9047E-05	6.0378E-05	6.1707E-05
	VEL Y	-5.3463E-05	-6.7370E-05	-7.9584E-05	-8.0545E-05	-9.6317E-05	-1.1033E-04	-9.9250E-05	-1.1825E-04	-1.3538E-04
88	VEL X	6.1470E-05	6.8684E-05	7.6449E-05	5.8401E-05	6.4414E-05	7.0543E-05	4.9011E-05	5.2295E-05	5.5513E-05
	VEL Y	-1.4291E-05	-3.1320E-05	-4.6099E-05	-3.5273E-05	-5.4807E-05	-7.1820E-05	-4.7389E-05	-7.0277E-05	-9.0429E-05
89	VEL X	3.3364E-04	3.8407E-04	4.0053E-04	2.9813E-04	3.2964E-04	3.7274E-04	2.3481E-04	2.5919E-04	3.0208E-04
	VEL Y	-2.6025E-06	-1.3205E-04	-2.6288E-04	3.8232E-05	-1.6554E-04	-3.6525E-04	8.4821E-05	-1.4303E-04	-3.9840E-04
90	VEL X	6.2359E-05	1.7545E-04	3.2886E-04	5.7481E-05	1.4324E-04	2.5178E-04	3.2956E-05	1.0804E-04	2.0100E-04
	VEL Y	1.7539E-04	1.2083E-04	6.5801E-05	3.5329E-04	2.7660E-04	1.4389E-04	4.2200E-04	3.6700E-04	2.0869E-04
91	VEL X	1.5727E-06	1.1777E-06	8.6705E-07	1.7083E-06	1.2135E-06	8.2339E-07	1.7026E-06	1.1238E-06	6.6582E-07
	VEL Y	5.5224E-06	5.2896E-06	5.1570E-06	5.0722E-06	4.9845E-06	5.0190E-06	4.4019E-06	4.5253E-06	4.8034E-06
92	VEL X	2.2957E-06	2.0804E-06	1.9285E-06	3.8014E-06	2.8041E-06	2.0976E-06	5.2698E-06	3.5099E-06	2.2570E-06
	VEL Y	7.1778E-06	6.2943E-06	5.8454E-06	6.8697E-06	5.8560E-06	5.3449E-06	6.3974E-06	5.1998E-06	4.6005E-06
93	VEL X	6.5740E-07	5.4358E-07	4.4915E-07	7.0153E-07	5.5471E-07	4.3273E-07	7.1383E-07	5.3691E-07	3.8966E-07
	VEL Y	5.4098E-06	5.3221E-06	5.2675E-06	5.2950E-06	5.2328E-06	5.2094E-06	5.1321E-06	5.1049E-06	5.1238E-06
94	VEL X	3.7039E-07	2.4717E-07	1.6394E-07	3.4138E-07	2.2261E-07	1.4238E-07	3.0802E-07	1.9450E-07	1.1782E-07
	VEL Y	5.0772E-06	5.0757E-06	5.0821E-06	5.0346E-06	5.0471E-06	5.0700E-06	4.9706E-06	5.0039E-06	5.0502E-06
95	VEL X	8.6851E-07	7.9755E-07	7.4220E-07	1.1481E-06	9.5047E-07	7.9569E-07	1.4060E-06	1.0852E-06	8.3337E-07
	VEL Y	5.9558E-06	5.7385E-06	5.5986E-06	5.8467E-06	5.6162E-06	5.4734E-06	5.6875E-06	5.4413E-06	5.2957E-06
96	VEL X	1.2840E-07	8.3991E-08	4.9730E-08	1.1034E-07	7.1670E-08	4.1840E-08	9.3355E-08	6.0268E-08	3.4755E-08
	VEL Y	4.6892E-06	4.9080E-06	4.9221E-06	4.8834E-06	4.9039E-06	4.9185E-06	4.8728E-06	4.8964E-06	4.9125E-06

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LISTING D-6. Output Report File for Test Case Two. (Sheet 46 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

RESULTS FOR VELOCITY (M/YR) OF YEAR 10.00

ELEMENT		QSS PNT 1	QSS PNT 2	QSS PNT 3	QSS PNT 4	QSS PNT 5	QSS PNT 6	QSS PNT 7	QSS PNT 8	QSS PNT 9
97	VEL X	3.9541E-08	1.9325E-08	2.6757E-09	3.3597E-08	1.6392E-08	2.2240E-09	2.7871E-08	1.3651E-08	1.9465E-09
	VEL Y	4.8074E-06	4.8143E-06	4.8167E-06	4.8046E-06	4.8130E-06	4.8153E-06	4.7998E-06	4.8104E-06	4.8127E-06
98	VEL X	1.3724E-06	1.7685E-06	2.1254E-06	1.9312E-06	2.7628E-06	3.4479E-06	3.5605E-06	4.7352E-06	5.5199E-06
	VEL Y	8.0537E-06	7.9896E-06	7.7377E-06	8.9028E-06	8.3408E-06	7.6121E-06	1.0047E-05	8.7631E-06	7.3760E-06
99	VEL X	7.1998E-05	8.6681E-05	9.0060E-05	6.7980E-05	8.1998E-05	8.5484E-05	6.3919E-05	7.7443E-05	8.1201E-05
	VEL Y	-9.7474E-06	-3.2239E-05	-6.0864E-05	-2.7784E-06	-2.4005E-05	-5.0548E-05	5.8732E-06	-1.3878E-05	-3.8222E-05
100	VEL X	6.2081E-05	7.5508E-05	7.8529E-05	5.5878E-05	6.8577E-05	7.1719E-05	4.9442E-05	6.1605E-05	6.5097E-05
	VEL Y	1.1339E-05	-7.8142E-06	-3.2220E-05	1.6812E-05	1.6618E-06	-2.0037E-05	2.8997E-05	1.3683E-05	-5.1946E-06
101	VEL X	8.8138E-06	3.0113E-05	5.4167E-05	7.9461E-06	2.7563E-05	5.0447E-05	6.6089E-06	2.4833E-05	4.6863E-05
	VEL Y	3.7926E-05	3.3036E-05	2.0585E-05	4.3481E-05	3.9803E-05	2.7388E-05	5.0061E-05	4.8086E-05	3.6170E-05
102	VEL X	6.8970E-07	7.8451E-07	8.5057E-07	1.0453E-06	1.1257E-06	1.1820E-06	1.5927E-06	1.6267E-06	1.6510E-06
	VEL Y	6.5633E-06	6.4035E-06	6.2080E-06	6.7747E-06	6.4809E-06	6.1448E-06	7.0221E-06	6.5580E-06	6.0430E-06
103	VEL X	4.0523E-07	4.8519E-07	5.9532E-07	6.9528E-07	8.0618E-07	9.3675E-07	1.2177E-06	1.3811E-06	1.5479E-06
	VEL Y	6.7315E-06	6.6880E-06	6.6535E-06	7.1425E-06	7.0251E-06	6.9229E-06	7.6452E-06	7.4307E-06	7.2423E-06
104	VEL X	4.4568E-07	4.1914E-07	3.9718E-07	5.2941E-07	4.6950E-07	4.1989E-07	6.0640E-07	5.1387E-07	4.3715E-07
	VEL Y	5.5650E-06	5.4812E-06	5.4184E-06	5.5290E-06	5.4396E-06	5.3739E-06	5.4737E-06	5.3782E-06	5.3094E-06
105	VEL X	3.5617E-07	2.6637E-07	2.0572E-07	3.7015E-07	2.6462E-07	1.9334E-07	3.7472E-07	2.5528E-07	1.7461E-07
	VEL Y	5.2347E-06	5.1681E-06	5.1307E-06	5.1928E-06	5.1354E-06	5.1119E-06	5.1326E-06	5.0885E-06	5.0838E-06
106	VEL X	3.9875E-07	4.2644E-07	4.4799E-07	5.3171E-07	5.3609E-07	5.3952E-07	7.0494E-07	6.8135E-07	6.6299E-07
	VEL Y	5.8807E-06	5.7800E-06	5.7004E-06	5.9143E-06	5.7955E-06	5.6773E-06	5.9673E-06	5.8021E-06	5.6372E-06
107	VEL X	1.6125E-07	1.0867E-07	6.8110E-08	1.4970E-07	9.9949E-08	6.1574E-08	1.3711E-07	9.0323E-08	5.4230E-08
	VEL Y	4.9450E-06	4.9379E-06	4.9340E-06	4.9325E-06	4.9284E-06	4.9281E-06	4.9129E-06	4.9136E-06	4.9187E-06
108	VEL X	2.4979E-07	3.1520E-07	3.6025E-07	3.5395E-07	4.3864E-07	4.9722E-07	5.3504E-07	6.2515E-07	6.8777E-07
	VEL Y	6.0620E-06	6.0214E-06	5.9600E-06	6.2199E-06	6.1406E-06	6.0378E-06	6.3992E-06	6.2730E-06	6.1200E-06
109	VEL X	5.3512E-08	2.6109E-08	3.5442E-09	4.8216E-08	2.3580E-08	3.2921E-09	4.2814E-08	2.0954E-08	2.9508E-09
	VEL Y	4.8245E-06	4.8250E-06	4.8239E-06	4.8203E-06	4.8218E-06	4.8213E-06	4.8134E-06	4.8166E-06	4.8170E-06
110	VEL X	2.4325E-07	6.7302E-07	1.1317E-06	7.7874E-08	1.0054E-06	2.0134E-06	-2.3950E-07	1.3101E-06	2.9642E-06
	VEL Y	8.5042E-06	8.4333E-06	8.1562E-06	9.4529E-06	9.4312E-06	9.1377E-06	1.0823E-05	1.0870E-05	1.0537E-05
111	VEL X	1.1308E-05	3.5006E-05	5.9280E-05	1.0519E-05	3.3179E-05	5.7164E-05	9.3199E-06	3.1205E-05	5.5207E-05
	VEL Y	1.8846E-05	1.4386E-05	1.5333E-06	2.5395E-05	2.1450E-05	8.2484E-06	3.2842E-05	2.9711E-05	1.6424E-05
112	VEL X	6.5372E-08	1.9590E-07	3.5871E-07	1.2411E-07	3.1236E-07	5.3722E-07	2.1506E-07	4.9048E-07	8.0473E-07
	VEL Y	6.8324E-06	6.8018E-06	6.7610E-06	7.3269E-06	7.2733E-06	7.2052E-06	7.9495E-06	7.8639E-06	7.7570E-06

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ELEMENT QSS PNT 1 QSS PNT 2 QSS PNT 3 QSS PNT 4 QSS PNT 5 QSS PNT 6 QSS PNT 7 QSS PNT 8 QSS PNT 9

RESULTS FOR VELOCITY (M/VR) OF YEAR 10.00

SAMPLE PROBLEM, FLUID AROUND A HEATED CANNISTER

LISTING D-6. Output Report File for Test Case Two. (Sheet 47 of 48)

113	VEL X	3.8072E-07	3.7288E-07	3.0293E-07	4.5373E-07	3.6597E-07	5.4998E-07	2.0547E-07	2.0547E-07	3.5865E-07
114	VEL X	1.6562E-07	2.5233E-07	1.4724E-07	1.1824E-06	6.2361E-06	6.0644E-06	6.2847E-06	2.4597E-07	2.2262E-07
115	VEL X	7.8571E-08	1.5291E-07	-9.1463E-07	-9.1463E-07	-4.7939E-09	-4.7939E-09	3.2604E-08	2.7410E-07	2.7410E-07
116	VEL X	2.3837E-07	2.4889E-07	2.5757E-07	2.9878E-07	2.9941E-07	3.8101E-07	3.6880E-07	3.5865E-07	3.5865E-07
117	VEL X	2.28204E-07	2.1353E-07	1.9053E-07	2.9522E-07	2.3773E-07	1.9878E-07	3.3389E-07	2.5161E-07	2.0366E-07
118	VEL X	1.7089E-07	2.0060E-07	2.2359E-07	2.2554E-06	5.6145E-06	5.6496E-06	2.5948E-07	2.8615E-07	3.5419E-07
119	VEL X	1.5691E-07	1.1011E-07	7.4007E-08	1.6243E-07	1.1261E-07	7.4171E-08	1.6347E-07	1.1118E-07	7.0848E-08
120	VEL X	9.6983E-08	1.2864E-07	1.5059E-07	1.2644E-07	5.7263E-06	5.7093E-06	5.8446E-06	5.0561E-07	2.5162E-07
121	VEL Y	5.7941E-08	2.8155E-08	3.6283E-08	5.7153E-08	2.8035E-08	4.0947E-09	5.5451E-08	2.7130E-08	3.8089E-09
122	VEL X	9.5487E-08	1.2979E-07	1.8491E-07	4.6455E-08	6.4107E-08	9.3625E-08	2.3399E-08	3.4102E-08	5.3144E-08
123	VEL X	1.14487E-07	1.2614E-07	1.3541E-07	1.4641E-06	5.4347E-06	5.1112E-06	1.6419E-07	1.7463E-07	2.1390E-07
124	VEL X	1.34498E-07	1.2620E-07	1.2027E-07	1.7753E-07	1.5965E-07	1.4757E-07	2.2035E-07	1.9332E-07	1.7505E-07
125	VEL Y	7.6589E-08	9.3288E-08	1.0614E-07	1.0429E-07	1.2618E-06	5.5263E-06	1.4336E-07	1.6901E-07	1.8884E-07
126	VEL X	1.0334E-07	7.4586E-08	5.2411E-08	3.2676E-07	9.0573E-08	5.0665E-06	5.0044E-06	1.4707E-07	1.0384E-07
127	VEL X	4.2379E-08	5.7681E-08	6.7967E-08	5.7716E-08	7.8645E-08	9.2783E-08	8.2858E-08	1.0751E-07	1.2425E-07
128	VEL X	4.2343E-08	2.0130E-08	1.8289E-09	4.9626E-08	2.4057E-08	3.0014E-09	5.5945E-08	5.6850E-06	5.6691E-06
129	VEL Y	4.8075E-06	4.8611E-06	4.8475E-06	4.8802E-06	4.8433E-06	4.8725E-06	4.8482E-06	4.8388E-06	4.8388E-06

LISTING D-6. Output Report File for Test Case Two. (Sheet 48 of 48)

SAMPLE PROBLEM, FLOW AROUND A HEATED CANNISTER

RESULTS FOR VELOCITY (M/YR) OF YEAR 10.00

ELEMENT		GSS PNT 1	GSS PNT 2	GSS PNT 3	GSS PNT 4	GSS PNT 5	GSS PNT 6	GSS PNT 7	GSS PNT 8	GSS PNT 9
129	VEL X	4.1871E-08	5.8084E-08	7.8800E-08	2.0664E-08	2.8301E-08	3.8414E-08	9.9494E-09	1.3659E-08	1.9106E-08
	VEL Y	5.5999E-06	5.6512E-06	5.7067E-06	5.6036E-06	5.6561E-06	5.7129E-06	5.6060E-06	5.6596E-06	5.7176E-06
130	VEL X	1.0633E-08	1.1856E-08	1.2859E-08	4.9058E-08	5.4393E-08	5.8772E-08	9.0513E-08	9.9714E-08	1.0728E-07
	VEL Y	5.4672E-06	5.4404E-06	5.4079E-06	5.4756E-06	5.4456E-06	5.4097E-06	5.4854E-06	5.4521E-06	5.4126E-06
131	VEL X	1.3813E-08	1.3072E-08	1.2572E-08	6.0608E-08	5.7451E-08	5.5317E-08	1.0636E-07	1.0099E-07	9.7357E-08
	VEL Y	5.3594E-06	5.2847E-06	5.1980E-06	5.3597E-06	5.2831E-06	5.1937E-06	5.3609E-06	5.2820E-06	5.1897E-06
132	VEL X	7.1111E-09	8.7994E-09	1.0092E-08	3.2659E-08	4.0017E-08	4.5661E-08	5.9915E-08	7.2743E-08	8.2605E-08
	VEL Y	5.5205E-06	5.5066E-06	5.4878E-06	5.5334E-06	5.5181E-06	5.4976E-06	5.5480E-06	5.5312E-06	5.5090E-06
133	VEL X	1.1336E-08	8.3051E-09	5.9674E-09	4.8954E-08	3.5681E-08	2.5443E-08	8.4501E-08	6.1252E-08	4.3320E-08
	VEL Y	5.1153E-06	5.0315E-06	4.9622E-06	5.1102E-06	5.0271E-06	4.9590E-06	5.1053E-06	5.0226E-06	4.9557E-06
134	VEL X	3.8021E-09	5.3389E-09	6.3587E-09	1.7815E-08	2.4490E-08	2.8942E-08	3.3468E-08	4.4934E-08	5.2620E-08
	VEL Y	5.5431E-06	5.5380E-06	5.5301E-06	5.5583E-06	5.5525E-06	5.5437E-06	5.5753E-06	5.5687E-06	5.5590E-06
135	VEL X	4.7136E-09	2.3158E-09	3.4133E-10	2.0447E-08	9.8645E-09	1.1508E-09	3.5477E-08	1.6779E-08	1.3819E-09
	VEL Y	4.9093E-06	4.8689E-06	4.8525E-06	4.9064E-06	4.8661E-06	4.8509E-06	4.9033E-06	4.8632E-06	4.8493E-06
136	VEL X	3.7762E-09	1.7458E-08	3.2083E-08	1.9475E-09	8.8549E-09	1.6045E-08	9.5869E-10	4.3218E-09	7.8138E-09
	VEL Y	5.5467E-06	5.5622E-06	5.5795E-06	5.5500E-06	5.5658E-06	5.5834E-06	5.5523E-06	5.5683E-06	5.5861E-06

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APPENDIX E
DIAGNOSTIC MESSAGES

The MAGNUM-2D computer code has evolved to the current version (3.1) over a number of years and has been tested with a variety of problems. It is therefore expected to provide trouble-free operation. However, for a computer program of such complexity, it is possible that difficulties may be encountered in its application. Moreover, any such problems are likely to arise from a lack of familiarity with the various features and input formats. Hence, MAGNUM-2D has the additional capability of diagnosing some possible input errors and a few run-time errors and generating appropriate warning/error messages.

The possible diagnostic messages as printed by MAGNUM-2D are reproduced in Table E-1 along with possible causes and/or corrective user action. Furthermore, since the input to MAGNUM-2D is in fixed format, the foremost remedial action is simply an exhaustive search of the inputs for incorrect data formatting. If unresolvable difficulties are encountered in the application of MAGNUM-2D to a well-posed problem, please contact the authors.

TABLE E-1: MAGNUM-2D Diagnostics. (Sheet 1 of 4)

MESSAGE	CAUSE/CORRECTIVE ACTION
I) PROGRAM CONTROL (CARD TYPES B, C, D) THE TEMPERATURE INPUT OPTION REQUIRES THAT A TEMPERATURE INPUT FILE BE SPECIFIED. ERROR STOP IN ROUTINE INPUTS. BOTH TEMPERATURE AND MOISTURE ARE INACTIVE. ERROR STOP IN ROUTINE INPUTS. TOO MANY NODES REQUESTED. LIMIT IS n. ERROR STOP IN ROUTINE INPUTS. TOO MANY ELEMENTS REQUESTED. LIMIT IS n. ERROR STOP IN ROUTINE INPUTS. TOO MANY MATERIAL TYPES REQUESTED. LIMIT IS n. ERROR STOP IN ROUTINE INPUTS. **WARNING: THE INTEGRATION CONSTANT ** * IS OUT OF THE SUGGESTED RANGE (1 TO 2)*	The temperature input file option has been selected, but no logical unit for the temperature input file has been specified. Neither heat transfer nor fluid flow has been selected. Either decrease the problem size or increase the node limit (MAXP). Either decrease the problem size or increase the element limit (MAXE). Either decrease the problem size or increase the material type limit (MAXMAT). Check the value of the integration constant echoed in the report file.
II) TIME STEPS (CARD TYPE E) TOO MANY TIME STEPPING DEFINITION CARDS ARE PRESENT IN THE INPUT DATA FILE. THE PROGRAM LIMIT IS n. ERROR STOP IN ROUTINE INPUTS.	Decrease the number of time step cards or increase the limit (NTT). Terminator card may have been omitted.
III) GEOMETRY INPUT (CARD TYPES G, H, OR EXTERNAL FILE) GEOMETRY HAS n NODES. THIS DOES NOT EQUAL THE NUMBER GIVEN IN THE PROBLEM SPECIFICATIONS DATA. ERROR STOP IN ROUTINE INPUTS. GEOMETRY HAS n ELEMENTS. THIS DOES NOT EQUAL THE NUMBER GIVEN IN THE PROBLEM SPECIFICATION DATA. ERROR STOP IN ROUTINE INPUTS. THE CHOICE OF AXISYMMETRIC COORDINATES IS INCOMPATIBLE WITH THE GEOMETRY. MINIMUM X < 0. ERROR STOP IN ROUTINE INPUTS. ERROR AT ELEMENT m MATERIAL TYPE n IS OUT OF RANGE. ERROR STOP IN ROUTINE INPUTS. ERROR IN THE ORDERING ARRAY, ELEMENT n DOES NOT APPEAR. ERROR STOP IN ROUTINE INPUTS.	The number of nodes, n, in the geometry input does not equal the number specified on card type B. The number of elements, n, in the geometry input does not equal the number specified on card type B. For an axisymmetric radial coordinate system the axis of symmetry is the line $x = 0$, and hence, all x-coordinates should be nonnegative. For element number m the material type index n is greater than the number of material types specified in card type B. Element number n is not assigned an ordering index in card type G.

TABLE E-1: MAGNUM-2D Diagnostics. (Sheet 2 of 4)

MESSAGE	CAUSE/CORRECTIVE ACTION
IV) INITIAL CONDITIONS (CARD TYPES J1, J2, AND EXTERNAL FILE) THE RESTART FILE HAS m1 NODES AND n1 RECORDS. THE CURRENT PROBLEM HAS m2 NODES AND n2 RECORDS. CHANGING THESE NUMBERS IS NOT PERMITTED ON RESTART. ERROR STOP IN ROUTINE INPUTS. ERROR IN THE INITIAL CONDITION INPUT, NODE n IS OUT OF RANGE. ERROR STOP IN ROUTINE INPUTS. ERROR IN THE INITIAL CONDITION INPUT, NODE n DOES NOT GET INITIALIZED. ERROR STOP IN ROUTINE INPUTS.	<p>The restart file contains problem size specifications that are incompatible with those contained in card type B.</p> <p>Node number n is assigned initial values, but does not exist in the problem geometry.</p> <p>Initial conditions are being input on a nodal basis (Eq. 11), but no initial values are assigned to node number n.</p>
V) BOUNDARY CONDITIONS (CARD TYPES K1, K2) TOO MANY BOUNDARY NODES, m REQUESTED, PROBLEM ONLY HAS n NODES. ERROR STOP IN ROUTINE INPUTS. ERROR IN BOUNDARY CONDITIONS, NODE n IS OUT OF RANGE. ERROR STOP IN ROUTINE INPUTS. ERROR IN BOUNDARY CONDITIONS, NODE m IS A DUPLICATE, LINE n OF BOUNDARY NODE LIST. ERROR STOP IN ROUTINE INPUTS. ** WARNING: ELEMENT n CONSISTS SOLELY * * OF SPECIFIED NODES * **	<p>The number, m, of specified boundary conditions exceeds the total number, n, of nodes.</p> <p>Node number n is assigned a boundary value, but does not exist in the problem geometry.</p> <p>Node number m is twice assigned a boundary value for one transport variable.</p> <p>All nodal values in element n are fixed and will not change during the simulation.</p>
VI) MATERIAL PROPERTIES (CARD TYPE M) ERROR IN ROCK PROPERTIES INPUT, MATERIAL TYPE n IS OUT OF RANGE. ERROR STOP IN ROUTINE INPUTS. ERROR IN ROCK PROPERTIES INPUT, ELEMENT m, MATERIAL TYPE n. NO MATERIAL PROPERTY DATA HAS BEEN READ FOR THIS MATERIAL TYPE. ERROR STOP IN ROUTINE INPUTS. **WARNING: LINE ELEMENTS OF ZERO FRACTURE WIDTH HAVE BEEN FOUND. THESE ELEMENT WIDTHS WILL BE SET TO UNITY. **	<p>Material type number n is greater than the number of material types specified on card type B.</p> <p>Element number m is assigned a nonexistent material type.</p> <p>The default fracture aperture for a line element is one length unit.</p>
 ERROR IN ROCK PROPERTIES INPUT. CONTINUUM ELEMENT NUMBER m HAS NON-ZERO FRACTURE WIDTH. ERROR STOP IN ROUTINE INPUTS.	<p>Fracture aperture has no meaning for a two-dimensional element. (cf. card type M)</p>

TABLE E-1: MAGNUM-2D Diagnostics. (Sheet 3 of 4)

MESSAGE	CAUSE/CORRECTIVE ACTION
VII) GEOMETRY FILE READ ERRORS ERROR READING GEOMETRY FILE HEADER RECORD. ERROR STOP IN ROUTINE INPUTS. ERROR READING GEOMETRY ELEMENT RECORDS. ERROR STOP IN ROUTINE INPUTS. ERROR READING GEOMETRY NODE COORDINATES. ERROR STOP IN ROUTINE INPUTS.	A read error or EOF occurred while reading the geometry file header record. A read error or EOF occurred while reading the geometry file connectivity records. A read error or EOF occurred while reading the geometry file nodal coordinate records.
VIII) HEAT SOURCE (CARD TYPE P, R1, R2) ERROR, m HEAT SOURCE ELEMENTS EXCEEDS PROGRAM MAXIMUM OF n. ERROR STOP IN ROUTINE LOADQ. ERROR, m THERMAL LOAD POINTS EXCEED THE PROGRAM MAXIMUM OF n. ERROR STOP IN ROUTINE LOADQ. ** WARNING: THERMAL LOADS ARE SET TO ** * ZERO FOR STEADY STATE RUNS.	Either decrease the number of heat source elements or increase the program limit (MAXH). Either decrease the number of points defining the source profile or increase the program limit (MAXT). Heat source options may not be used with steady-state runs. (cf. Section 3.5).
IX) TEMPERATURE INPUT FILE ERRORS ERROR, n COMPONENTS ON TEMPERATURE INPUT FILE. INPUT REQUIRES ONLY ONE COMPONENT ON THIS FILE. ERROR STOP IN ROUTINE HEADR. ERROR, m DATA POINTS ON TEMPERATURE INPUT FILE. INPUT REQUIRES n NODES TO MATCH CURRENT GEOMETRY SIZE. ERROR STOP IN ROUTINE HEADR. **WARNING: TEMPERATURE INPUT FILE HAS ** * MOISTURE DATA ON IT, OR WAS NOT GENERATED BY MAGNUM-2D ** ERROR OR END OF FILE ENCOUNTERED AT TEMPERATURE INPUT FILE HEADER READ. ERROR STOP IN ROUTINE HEADR. THE INPUT TEMPERATURE FILE BEGINS AT TIME x, WHICH EXCEEDS THE SIMULATION INITIAL TIME. ERROR STOP IN MAIN ROUTINE. THE INPUT TEMPERATURE FILE ENDS AT TIME x, AFTER READING n RECORDS. ERROR STOP IN MAIN ROUTINE. ERROR READING TEMPERATURE FILE AT TIME x, AFTER READING n RECORDS. ERROR STOP IN MAIN ROUTINE.	The temperature input file must contain temperature data only. There must be a one-to-one correspondence between the number of nodal temperatures in the temperature input file and the number of nodes in the current geometry. The temperature input file header does not correspond to the expected format. A read error or EOF occurred while reading the temperature input file header record. The temperature input file contains data for times that do not correspond to current simulation times. The temperature file ends prematurely. Read error occurred while reading data records from the temperature input file.

TABLE E-1: MAGNUM-2D Diagnostics. (Sheet 4 of 4)

MESSAGE	CAUSE/CORRECTIVE ACTION
X) EXECUTION ERRORS	
NO ACTIVE ELEMENTS FOUND IN GEOMETRY. ERROR STOP IN ROUTINE SETUP.	Every node is a boundary node.
ERROR IN NODE SEQUENCING. m NODES PERMITTED. TWICE THAT NUMBER OF EQUATIONS ARE PERMITTED. n EQUATIONS HAVE BEEN SET UP FOR THIS PROBLEM. ERROR STOP IN ROUTINE SETUP.	Array storage is overutilized by the solver. Check geometry and especially the element ordering.
TEMPERATURE INPUT TO FPROP IS OUT OF RANGE AT NODE m, TEMPERATURE IS x. ALLOWABLE RANGE IS FROM y TO z. SIMULATION TIME IS t. ERROR STOP IN ROUTINE FPROP.	Empirical relations employed in updating temperature-dependent material properties are only valid in the indicated range.
NELL = m IS GREATER THAN MAXE (= n). ERROR STOP IN ROUTINE FRONT.	Possible incompatibility between element connectivity and element ordering.
LCOL = m, NELL = n. THE DIFFERENCE (NMAX-NCRIT) IS NOT SUFFICIENTLY LARGE TO PERMIT THE ASSEMBLY OF THE NEXT ELEMENT. EITHER INCREASE NMAX OR LOWER NCRIT. (POSSIBLE GEOMETRY BAND- WIDTH/ORDERING ERROR). ERROR STOP IN ROUTINE FRONT.	The frontwidth requires adjustment to arrange storage as indicated, or optimization of element ordering.
END OF FILE ENCOUNTERED ON FILE n. ERROR STOP IN ROUTINE RED.	An EOF occurred while reading the scratch file used by the solver.
WARNING: MATRIX SINGULAR OR ILL- CONDITIONED, x IS LESS THAN y, EQUATION NUMBER m. ERROR IN FRONT AT LOCATION n. ERROR STOP IN ROUTINE FRONT.	Either the material properties are zero or highly contrasting.
BINARY READ SIZE ERROR. ROUTINE BININ MUST BE MODIFIED SO THAT m OR MORE RECORDS CAN BE READ AT ONCE. ERROR STOP IN ROUTINE BININ.	Direct I/O block size is not large enough for scratch file.
BINARY WRITE ERROR. ROUTINE BINOUT MUST BE MODIFIED SO THAT m OR MORE RECORDS CAN BE WRITTEN AT ONCE. ERROR STOP IN ROUTINE BINOUT.	Direct I/O block size is not large enough for scratch file.

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